PEDESTRIAN WIND ENVIRONMENT STUDY

WG415-02- 711 HUNTER STREET, NEWCASTLE WEST, NSW 2302

WG415-02F02(REV2)- WE REPORT

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Prepared for:

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EXECUTIVE SUMMARY

This report presents the results of a detailed investigation into the wind environment impact of the 711 Hunter Street development, located in Newcastle West. Testing was performed at Windtech's boundary layer wind tunnel facility. The wind tunnel has a 3.0m wide working section and a fetch length of 14m, and measurements were taken from 16 wind directions at 22.5 degree increments. Testing was carried out using a 1:300 detailed scale model of the development. The effects of nearby buildings and land topography have been accounted for through the use of a proximity model which represents an area with a radius of 450m.

Peak gust and mean wind speeds were determined at selected critical outdoor trafficable locations within and around the subject development. Wind velocity coefficients representing the local wind speeds are derived from the wind tunnel and are combined with a statistical model of the regional wind climate (which accounts for the directional strength and frequency of occurrence of the prevailing regional winds) to provide the equivalent full-scale wind speeds at the site. The wind speed measurements are compared with criteria for pedestrian comfort and safety, based on Gust-Equivalent Mean (GEM) and annual maximum gust winds, respectively.

The model was tested in the wind tunnel without the effect of any forms of wind ameliorating devices such as screens, balustrades, etc., which are not already shown in the architectural drawings. The effect of vegetation was also excluded from the testing. Several building scenarios were tested. These are as follows:

- With the inclusion of the Stage 1 Tower only. In this report, this test case is referred to as the "Stage 1 Case".
- With the inclusion of both the Stage 1 Tower and Stage 2 Tower. In this report, this test case is referred to as the "Stage 2 Case".
- With only the existing surrounding buildings. In this report, this test case is referred to as the "Existing Case".

The results of the study indicate that some areas will experience strong winds which will exceed the relevant criteria for comfort and/or safety. Since the wind tunnel testing, the design of the development has been updated. The new architectural drawings/landscaping plans (received 31 October, 2022) show additional architectural/landscape elements which have been included in the design to address some of the strong wind conditions. The architectural/landscape elements shown in the updated drawings which are expected to mitigate these winds are as follows (and recommended to be retained in the final design):

Ground Level:

- Densely foliating evergreen tree planting along the south-western driveway, the south-western aspect of the Stage 2 Tower, the through-site link between the Stage 1 and Stage 2 Towers and the corner of Hunter Street and National Park Street.
- Impermeable wrap-around awning along the north-western, south-western and south-eastern aspects of the Stage 2 building.
- Water meter/fire booster valves along the north-eastern aspect of the Stage 1 Tower.

- Car park permeability along podium levels expected to assist in wind mitigation.

Level 02:

- Dense planting, approximately 2m in height, along the northern aspect of the Level 2 communal space.

Level 05:

- 1.8m high impermeable, transparent wind screens in the outdoor courtyard area on the podium level, between the Stage 1 and Stage 2 tower.
- Full-height impermeable inter-tenancy screens on the tenancies located on the Stage 2 Tower.
- Tall, densely foliating evergreen trees on the western side of the courtyard area, in-between the two towers near the turf space and to the north-east of the Stage 2 tower.
- Impermeable wrap-around awning, on the western edge and a portion of the southern and northern edges of the Stage 1 Tower.
- Impermeable awning, along the southern straight edge of the Stage 2 Tower as well as the western straight edge, eastern straight edge and northern-curved corner.
- Full-height, impermeable vertical baffle screen arrangement on the Level 05 southern balcony of the Stage 2 Tower.

Tower Levels:

- Full-height impermeable end screen along the north-eastern corner balcony of the Stage 1 tower, between Levels 06 to 16.
- Full-height impermeable end screen along the south-eastern corner balcony of the Stage 1 tower, between Levels 17 to 25.
- 2m high impermeable perimeter screen along the Level 17 communal terrace area on the Stage 1 tower.
- Full-height impermeable screen on the curved edge of the Stage 2 Tower western corner balcony, along Levels 14 to 25.
- Full-height impermeable screen along the south-western corner terrace of the Stage 2 tower.

It is recommended that a 3m high hoarding be included around the Stage 2 site for the duration of the construction period and until the Stage 2 development has been completed. As a general note, the use of loose glass-tops and light-weight sheets or covers (including loose BBQ lids) is not appropriate on high-rise outdoor terraces and balconies. Furthermore, lightweight furniture is not recommended unless it is securely attached to the balcony or terrace floor slab.

With the retention of the above architectural/landscape features in the final design, it is expected that wind conditions for all outdoor trafficable areas within and around the development, will be suitable for their

intended uses. Nonetheless, additional wind tunnel testing is recommended to be undertaken at a more detailed design stage to quantitatively assess the wind conditions and to optimise the size and extent of the treatments required.

CONTENTS

1 INTRODUCTION

1.1 Overview

The Pedestrian Wind Environment Study has been prepared by Windtech Consultants on behalf of Hunter Street JV CoP/L (the applicant). It accompanies a Statement of Environmental Effects (SEE) in support of a Development Application (DA) at 711 Hunter Street, Newcastle West (the site).

This name of Pedestrian Wind Environment Study quantitatively assesses the wind speeds at selected critical outdoor trafficable areas within and around the subject development with regards to pedestrian amenity and safety.

The development has undergone an Architectural Design Competition where three competitors put forward their designs in accordance with the brief. The Plus Architecture scheme was recommended by the Jury as the winning scheme in the competitive design process.

The overall outcome of the proposal aims to develop a mixed-use precinct with high quality tower forms providing a positive relationship to the immediate surrounds and acknowledging the surrounding heritage context. The proposal intends to act as a landmark for Newcastle West with a curated mix of eclectic and creative retail, F&B and commercial opportunities activating the ground levels.

The key features are summarised below:

- Demolition of the existing commercial premises and ancillary structures on-site;
- Construction of a mixed-use precinct forming active ground and podium levels reaching 5 storeys of retail and commercial tenancies, with two tower forms for residential apartments reaching 26 storeys comprising of 258 apartments;
- Podium level car park for 300 cars incorporated within the podium levels;
- Communal open space for residents located on level 5 and 17;
- Vehicle access to the site via Little King Street;
- Associated landscaping with the public domain improvements;
- An urban plaza fronting National Park Street providing opportunities for activation and public art; and
- Construction of ancillary infrastructure and utilities as required.

It is noted that the overall development will form two separate concurrent DAs. Stage 1 will form the northern tower and podium elements and Stage 2 will form the southern tower and podium elements. These separate DA components are explored further below.

Stage 1:

The northern tower will include commercial and retail tenancies at ground level which will be accessible via National Park Street, Little King Street and Hunter Street. The podium levels will be situated above ground and

contain car parking for both visitors and residents, accessed via Little King Street. Level 5 to Level 25 will contain a mixture of residential apartments ranging from 1 bedroom to 3 bedrooms. A numerical breakdown of Stage 1 is shown below:

- 136 apartments including: 35 one bedroom, 74 two bedroom, 26 three bedroom, 1 four bedroom.
- Total GFA: 13, 581 sqm
- Floor space ratio: 5.41:1
- Total car parking spaces: 165 spaces over 4 podium levels

Stage 2:

The southern tower will include commercial and retail tenancies at ground level which will be accessible via National Park Street, Little King Street and Hunter Street. The podium levels will be situated above ground

and contain car parking for both visitors and residents, accessed via Little King Street. Level 1 to Level 25 will contain a mixture of residential apartments ranging from 1 bedroom to 3 bedrooms.

- 122 apartments including: 35 one bedroom, 72 two bedroom, 15 three bedroom.
- Total GFA: 12,027 sqm
- Floor space ratio: 5.43:1
- Total car parking spaces: 135 spaces over 4 podium levels

Both stages will include surrounding landscaping, public domain works and green spaces. The strata and stratum approach are detailed further in the SEE.

1.2 Site Details

Site address: 711 Hunter Street, Newcastle West

Lot and DP: as Lot 1 in DP 867617

Site area: 4,724m22

Boundaries: The site has frontages of 48m to Hunter Street to the north, 113m to National Park Street to the east and 43m to King Street to the south.

Heritage Significance: Not identified as a heritage item but is adjoining an identified local heritage item to the south-west, namely the Army Drill Hall (I508) located at 498 King Street and is diagonally adjacent to the Bank Corner which is a locally listed heritage item located at 744 Hunter Street. The site is also located within the Newcastle City Centre Heritage Conservation Area.

Figure 1: Site Location (Source: Urbis)

2 WIND TUNNEL TESTING

A wind tunnel study has been undertaken to determine wind speeds at selected critical outdoor trafficable areas within and around the subject development. The test procedures followed for this wind tunnel study were based on the guidelines set out in the Australasian Wind Engineering Society Quality Assurance Manual (AWES-QAM-1-2019), ASCE 7-16 (Chapter C31), and CTBUH (2013).

A scale model of the development was prepared, including the surrounding buildings and land topography. Testing was performed at Windtech's boundary layer wind tunnel facility. The wind tunnel has a 3.0m wide working section and a fetch length of 14m, and measurements were taken from 16 wind directions at 22.5 degree increments. The wind tunnel was configured to the appropriate boundary layer wind profile for each wind direction. Wind speeds were measured using either Dantec hot-wire probe anemometers or pressure-based wind speed sensors, positioned to monitor wind conditions at critical outdoor trafficable areas of the development.

The model was tested in the wind tunnel without the effect of any forms of wind ameliorating devices such as screens, balustrades, etc., which are not already shown in the architectural drawings. The effect of vegetation was also excluded from the testing. The wind speeds measured during testing were combined with a statistical model of the regional wind climate to provide the equivalent full-scale wind speeds at the site. The measured wind speeds were compared against appropriate criteria for pedestrian comfort and safety, and in-principle treatments have been recommended for any area which was exposed to strong winds. These treatments could be in the form of retaining vegetation that is already proposed for the site, or including additional vegetation, screens, awnings, etc. Note however that, in accordance with the AWES Guidelines (2014), only architectural elements or modifications are used to treat winds which represent an exceedance of the existing wind conditions and exceed the safety limit.

3 WIND TUNNEL MODEL

Wind tunnel testing was carried out using a 1:300 scale model of the development and surroundings. The study model incorporates all necessary architectural features on the façade of the development to ensure an accurate wind flow is achieved around the model, and was constructed using a Computer Aided Manufacturing (CAM) process to ensure that a high level of detail and accuracy is achieved. The effect of nearby buildings and land topography has been accounted for through the use of a proximity model, which represents a radius of 450m around the development site. Several building scenarios were tested. These are as follows:

- With the inclusion of the Stage 1 Tower only. In this report, this test case is referred to as the "Stage 1 Case".
- With the inclusion of both the Stage 1 Tower and Stage 2 Tower. In this report, this test case is referred to as the "Stage 2 Case".
- With only the existing surrounding buildings. In this report, this test case is referred to as the "Existing Case".

Photographs of the wind tunnel models for each of the abovementioned scenarios are presented in Figures 2. Plan figures of the proximity models are also provided in Figures 3.

Figure 2a: Photograph of the Wind Tunnel Model
Stage 1 Case, view from the east

Figure 2b: Photograph of the Wind Tunnel Model
Stage 1 Case, view from the north-east

Figure 2c: Photograph of the Wind Tunnel Model
Stage 1 Case, view from the east

Figure 2d: Photograph of the Wind Tunnel Model
Stage 1 Case, view from the south

Figure 2e: Photograph of the Wind Tunnel Model
Stage 1 Case, view from the south-west

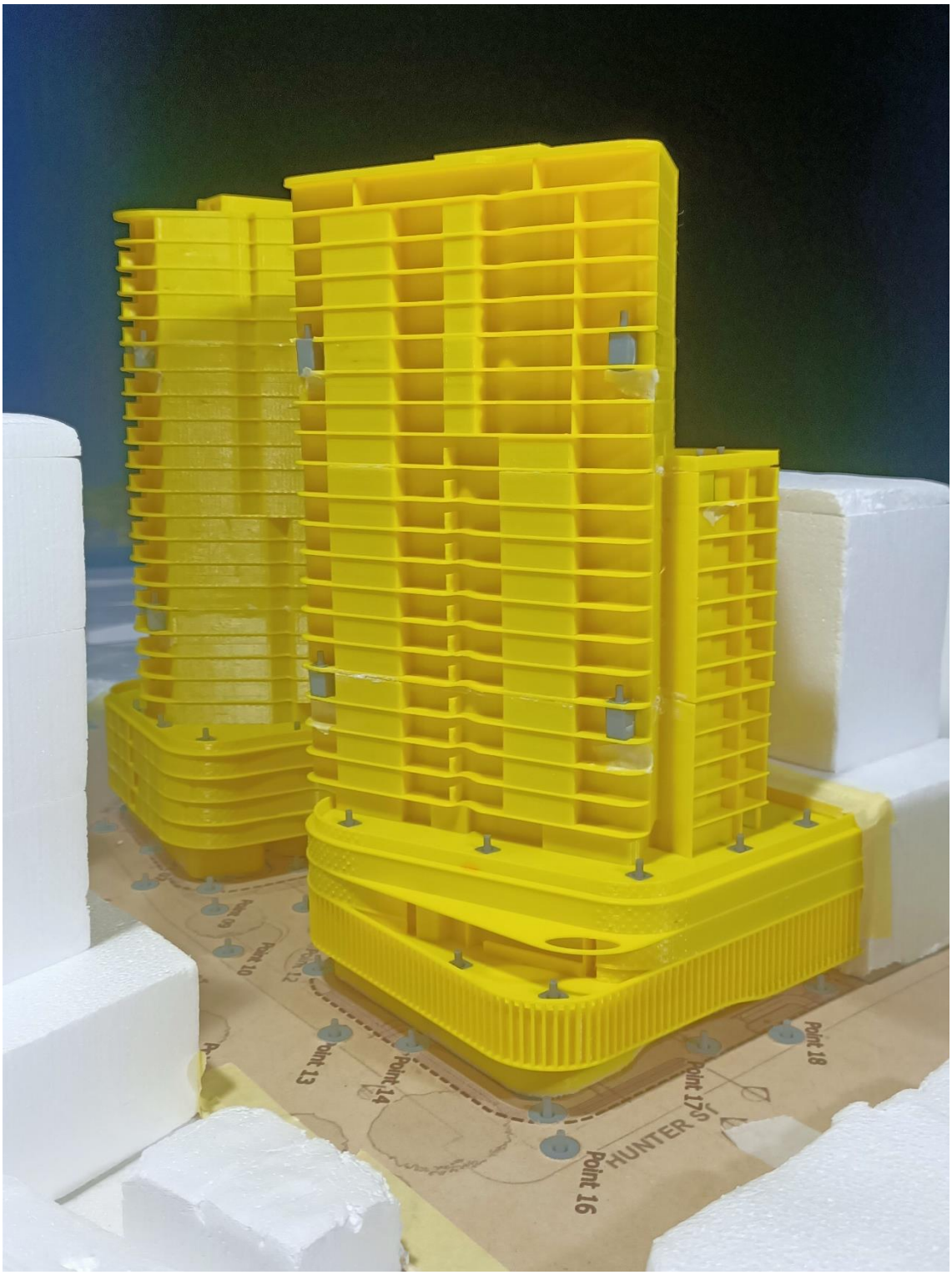

Figure 2f: Photograph of the Wind Tunnel Model
Stage 2 Case, view from the east

Figure 2g: Photograph of the Wind Tunnel Model
Stage 2 Case, view from the south

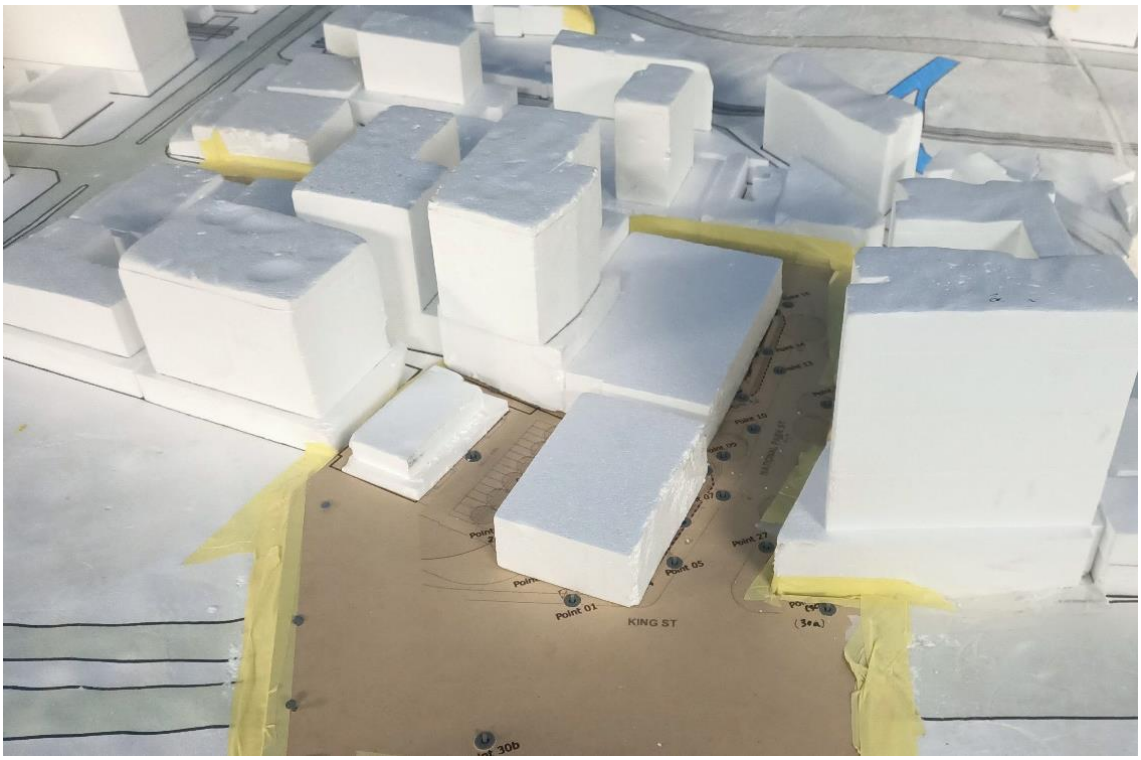

Figure 2h: Photograph of the Wind Tunnel Model
Existing Case, view from the south

Figure 3a: Proximity Model Plan
Stage 1 Case

Figure 3b: Proximity Model Plan
Stage 2 Case

Figure 3c: Proximity Model Plan
Existing Case

4 BOUNDARY LAYER WIND PROFILES AT THE SITE

The roughness of the surface of the earth has the effect of slowing down the wind near the ground. This effect is observed up to the boundary layer height, which can range between 500m to 3km above the earth's surface depending on the roughness of the surface (i.e.: oceans, open farmland, etc). Within this range the prevailing wind forms a boundary layer wind profile.

Various wind codes and standards and other publications classify various types of boundary layer wind flows depending on the surface roughness z_0. Descriptions of typical boundary layer wind profiles, based on D.M. Deaves and R.I. Harris (1978), are summarised as follows:

- Flat terrain (0.002m < z_0 < 0.003m). Examples include inland water bodies such as lakes, dams, rivers, etc, and the open ocean.
- Semi-open terrain (0.006m < z_0 < 0.01m). Examples include flat deserts and plains.
- Open terrain (0.02m < z_0 < 0.03m). Examples include grassy fields, semi-flat plains, and open farmland (without buildings or trees).
- Semi-suburban/semi-forest terrain (0.06m < z_0 < 0.1m). Examples include farmland with scattered trees and buildings and very low-density suburban areas.
- Suburban/forest terrain (0.2m < z_0 < 0.3m). Examples include suburban areas of towns and areas with dense vegetation such as forests, bushland, etc.
- Semi-urban terrain (0.6m < z_0 < 1.0m). Examples include centres of small cities, industrial parks, etc.
- Urban terrain (2.0m < z_0 < 3.0m). Examples include centres of large cities with many high-rise towers, and also areas with many closely-spaced mid-rise buildings.

The boundary layer wind profile does not change instantly due to changes in the terrain roughness. It can take many kilometres (at least 100km) of a constant surface roughness for the boundary layer wind profile to achieve a state of equilibrium. Hence an analysis of the effect of changes in the upwind terrain roughness is necessary to determine an accurate boundary layer wind profile at the development site location.

The proximity model accounts for the effect of the near field topographic effects as well as the influence of the local built forms. To account for further afield effects, an assessment of the upwind terrain roughness has been undertaken based on the method given in AS/NZS1170.2:2011, using a fetch ranging from 20 to 60 times the study reference height (as per the recommendation by AS/NZS1170.2:2011). An aerial image showing the surrounding terrain is presented in Figure 4 for a range of 3.2km from the edge of the proximity model used for the wind tunnel study. The resulting mean and gust terrain and height multipliers at the site location are presented in Table 1, referenced to the study reference height (which is approximately half the height of the subject development). Details of the boundary layer wind profiles at the site are combined with the regional wind model (see Section 5) to determine the site wind speeds.

Table 1: Approaching Boundary Layer Wind Profile Analysis Summary (at the study reference height)

Wind Sector (degrees)	Terrain and Height Multiplier $k_{tr,T=1hr}$ (hourly)	$k_{tr,T=10min}$ (10min)	$k_{tr,T=3s}$ (3sec)	Turbulence Intensity I_v	Equivalent Terrain Category (AS/NZS1170.2:2011 naming convention)
0	0.68	0.72	1.10	0.209	3.0
30	0.81	0.85	1.19	0.155	2.1
60	0.77	0.80	1.16	0.171	2.4
90	0.79	0.82	1.17	0.165	2.3
120	0.81	0.85	1.19	0.155	2.1
150	0.84	0.87	1.20	0.147	1.9
180	0.78	0.82	1.17	0.165	2.3
210	0.67	0.71	1.10	0.212	3.0
240	0.67	0.71	1.10	0.212	3.0
270	0.71	0.75	1.13	0.194	2.8
300	0.67	0.71	1.10	0.212	3.0
330	0.67	0.71	1.10	0.212	3.0

NOTE: These terrain and height multipliers are to be applied to a basic regional wind speed averaged over 3-seconds. Divide these values by 1.10 for a basic wind speed averaged over 0.2-seconds, 0.69 for a basic wind speed averaged over 10-minutes, or 0.66 for a basic wind speed averaged over 1-hour.

For each of the 16 wind directions tested in this study, the approaching boundary layer wind profiles modelled in the wind tunnel closely matched the profiles listed in Table 1. Plots of the boundary layer wind profiles used for the wind tunnel testing are presented in Appendix D of this report.

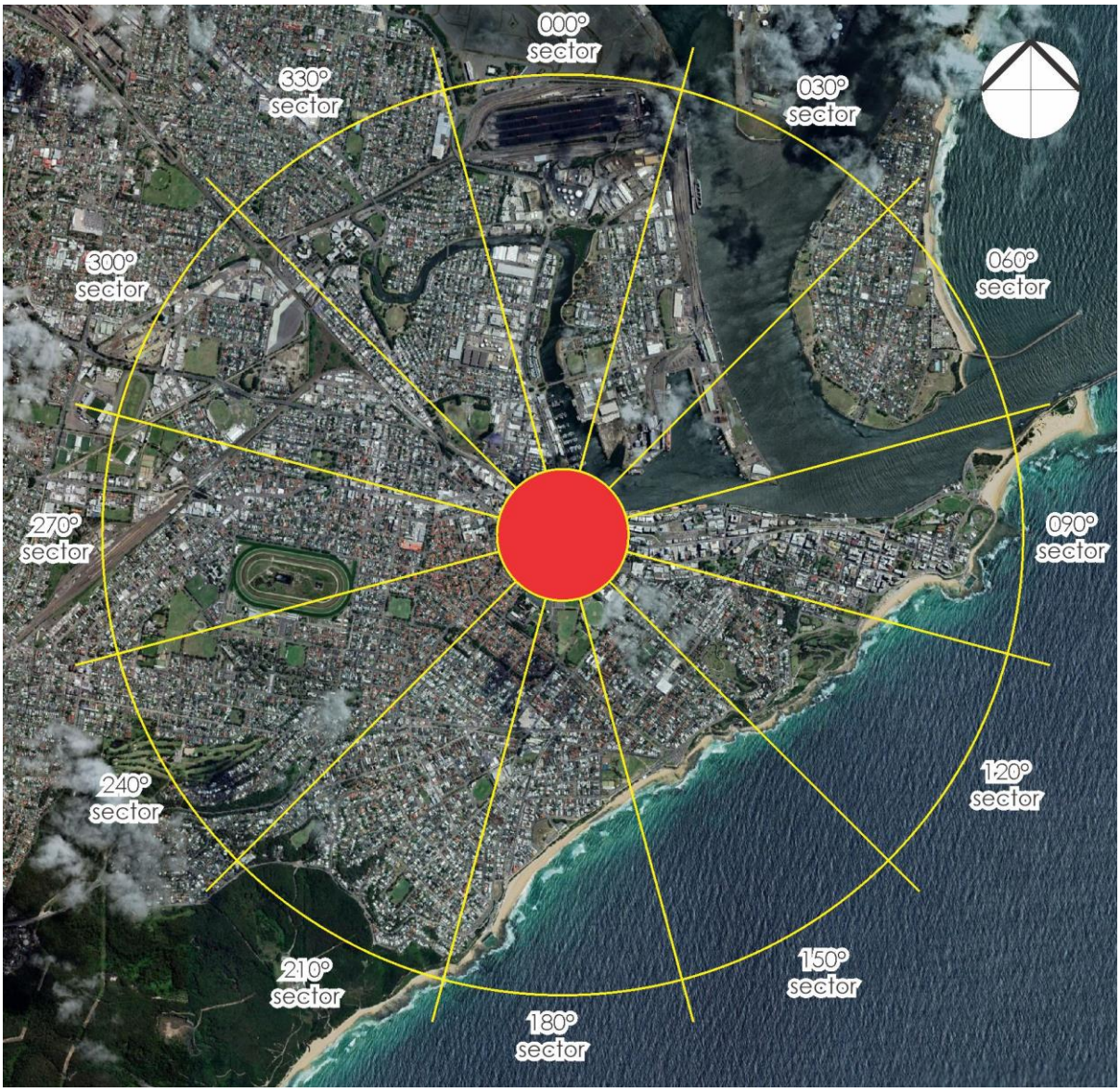

Figure 4: Aerial Image of the Surrounding Terrain (radius of 3.2km from the edge of the proximity model)

5 REGIONAL WIND MODEL

The regional wind model used in this study was determined from an analysis of measured directional mean wind speeds obtained at the meteorological recording station located at Williamtown RAAF. Data was collected from 1958 to 2013 and corrected so that it represents winds over standard open terrain at a height of 10m above ground for each wind direction. From this analysis, directional probabilities of exceedance and directional wind speeds for the region are determined. The directional wind speeds are summarised in Table 2. The directional wind speeds and corresponding directional frequencies of occurrence are presented in Figure 5.

The analysis indicates that the strongest winds of the region are mainly governed by west-north-westerly winds, which are also the most frequently occurring winds for the region. The north-westerly winds are the next strongest and frequent.

The recurrence intervals examined in this study are for exceedances of 5% (per 90 degree sector) of the pedestrian comfort criteria using Gust-Equivalent Mean (GEM) wind speeds, and annual maximum wind speeds (per 22.5 degree sector) for the pedestrian safety criterion. Note that the 5% probability wind speeds presented in Table 2 are only used for the directional plot presented in Figure 5 and are not used for the integration of the probabilities.

Table 2: Regional Directional Wind Speeds (hourly means, at 10m height in standard open terrain) (m/s)

Wind Direction	5% Exceedance	Annual Maximum
N	3.4	6.2
NNE	4.5	7.3
NE	6.5	9.3
ENE	7.7	10
E	6.8	9.8
ESE	7.1	9.6
SE	7.1	10.5
SSE	7.6	10.4
S	8.3	11.5
SSW	7.7	11.6
SW	5.6	10.4
WSW	5.1	10.1
W	7.9	12.6
WNW	11.4	15.6
NW	7.8	13.1
NNW	3.9	7.8

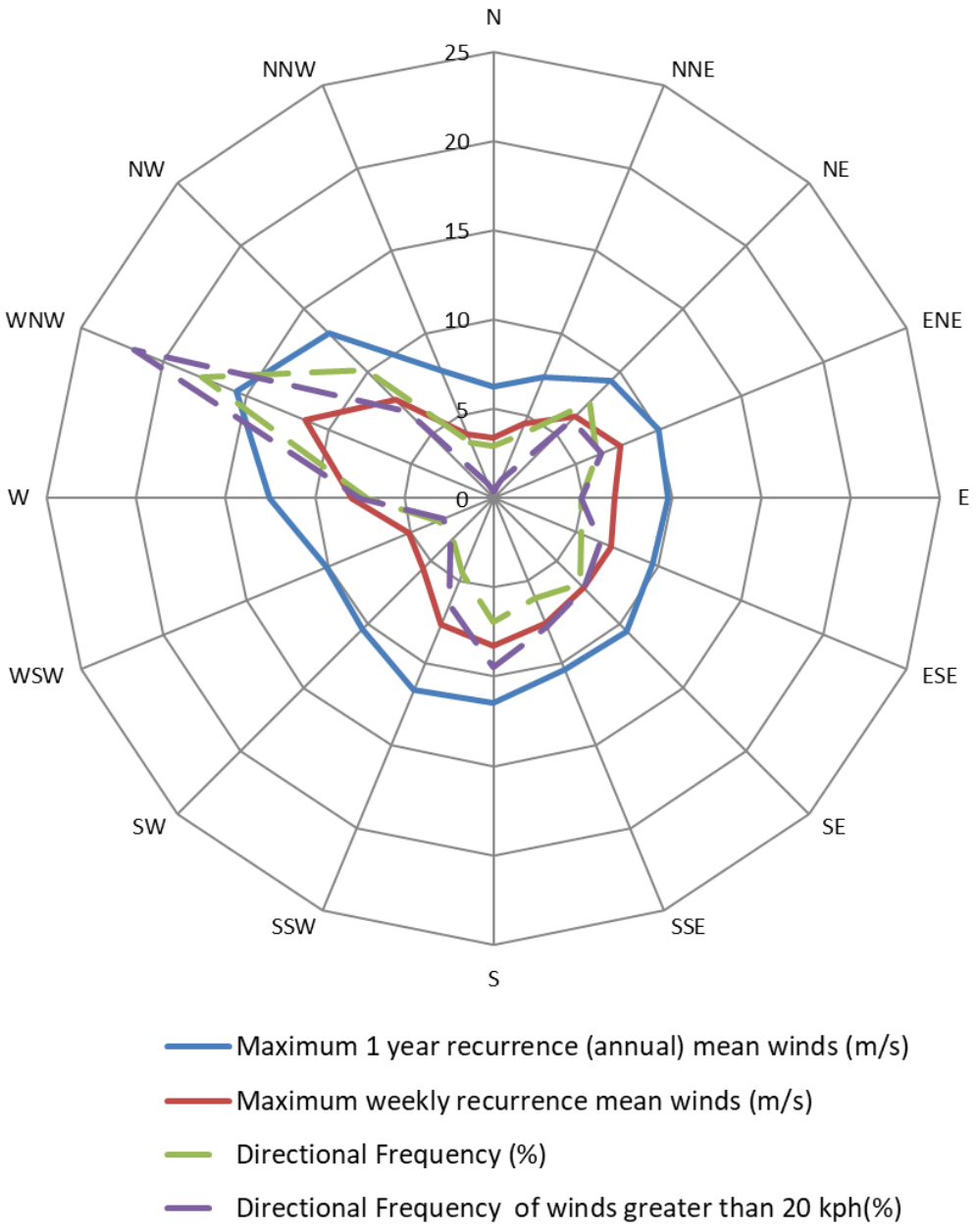

Figure 5: Annual and 5% Exceedance Hourly Mean Wind Speeds, and Frequencies of Occurrence, for the Newcastle Region (at 10m height in standard open terrain)

6 PEDESTRIAN WIND COMFORT AND SAFETY

The acceptability of wind conditions for an area is determined by comparing the measured wind speeds against an appropriate criteria. This section outlines how the measured wind speeds were obtained, the criteria considered for the development, as well as the critical trafficable areas that were assessed and their corresponding criteria designation.

6.1 Measured Wind Speeds

Wind speeds were measured using either Dantec hot-wire probe anemometers or pressure-based wind speed sensors, positioned to monitor wind conditions at critical outdoor trafficable areas of the development. The reference mean free-stream wind speed measured in the wind tunnel, which is at a full-scale height of 200m and measured 3m upstream of the study model.

Measurements were acquired for 16 wind directions at 22.5 degree increments using a sample rate of 1,024Hz. The full methodology of determining the wind speed measurements at the site from either the Dantec Hot-wire probe anemometers or pressure-based wind speed sensors is provided in Appendix B. Based on the results of the analysis of the boundary layer wind profiles at the site (see Section 4), and incorporating the regional wind model (see Section 5), the data sampling length of the wind tunnel test for each wind direction corresponds to a full-scale sample length ranging between 30 minutes and 1 hour. Research by A.W. Rofail and K.C.S. Kwok (1991) has shown that, in addition to the mean and standard deviation of the wind being stable for sample lengths of 15 minutes or more (full-scale), the peak value determined using the upcrossing method is stable for sample lengths of 30 minutes or more.

6.2 Wind Speed Criteria Used for This Study

For this study the measured wind conditions of the selected critical outdoor trafficable areas are compared against two sets of criteria; one for pedestrian safety, and one for pedestrian comfort. The safety criterion is applied to the annual maximum gust winds, and the comfort criteria is applied to Gust Equivalent Mean (GEM) winds. In accordance with ASCE (2003), the GEM wind speed is defined as follows:

$$GEM = max\left(\bar{V}, \frac{\hat{V}}{1.85}\right) \tag{6.1}$$

where:

- $\bar{V}$ is the mean wind speed.
- $\hat{V}$ is the 3-second gust wind speed.

For pedestrian safety, the safety limit criterion of 23m/s applies to 3-second duration annual maximum gust winds for all areas, in accordance with W.H. Melbourne (1978).

For pedestrian comfort, the T.V. Lawson (2001) criteria are used in conjunction with the GEM wind speed using a 5% probability of exceedance. Research by A.W. Rofail (2007) has shown that the T.V. Lawson (2001) criteria,

used in conjunction with a GEM wind speed, has proven over time and through field observations to be the most reliable indicator of pedestrian comfort. A more detailed comparison of published criteria has been provided in Appendix A.

The criteria considered in this study are summarised in Tables 3 and 4 for pedestrian comfort and safety, respectively. The results of the wind tunnel study are presented in the form of directional plots attached in Appendix C of this report. For each study point there is a plot of the GEM wind speeds using the comfort criteria, and a plot for the annual maximum gust wind speeds using the safety criterion.

Table 3: Comfort Criteria (from T.V. Lawson, 2001)

Classification	Description	Maximum 5% Exceedance GEM Wind Speed (m/s)
Sitting	Long duration stationary activities such as in outdoor restaurants and theatres, etc.	4.0
Standing	Short duration stationary activities (generally less than 1 hour), including window shopping, waiting areas, etc.	6.0
Walking	For pedestrian thoroughfares, private swimming pools, most communal areas, private balconies and terraces, etc.	8.0

Table 4: Safety Criterion (from W.H. Melbourne, 1978)

Classification	Description	Annual Maximum Gust Wind Speed (m/s)
Safety	Safety criterion applies to all trafficable areas.	23

6.3 Layout of Study Points

For this study a total of 71 study point locations were selected for analysis in the wind tunnel. This includes the following:

- 32 study points on Ground Floor, around commercial facilities as well as the main entrances, along the pedestrian footpaths, trafficable areas around the lobby entrances as well as at the neighbouring carpark.
- 2 study points on Level 02, around the Roof Bar area and private balcony.
- 21 study points on Level 05, around outside recreational facilities and private open spaces.
- 6 study points on the various elevated private balconies along the Stage 1 Tower.
- 8 study points on the various elevated private balconies along the Stage 2 Tower.
- 2 study points on the Level 17 communal terrace area.

The locations of the various study points tested for this study, as well as the target wind speed criteria for the various outdoor trafficable areas of the development, are presented in Figures 6 in the form of marked-up plans. It should be noted that only the most critical outdoor locations of the development have been selected for analysis.

Figure 6a: Study Point Locations and Target Wind Speed Criteria – Ground Floor Plan

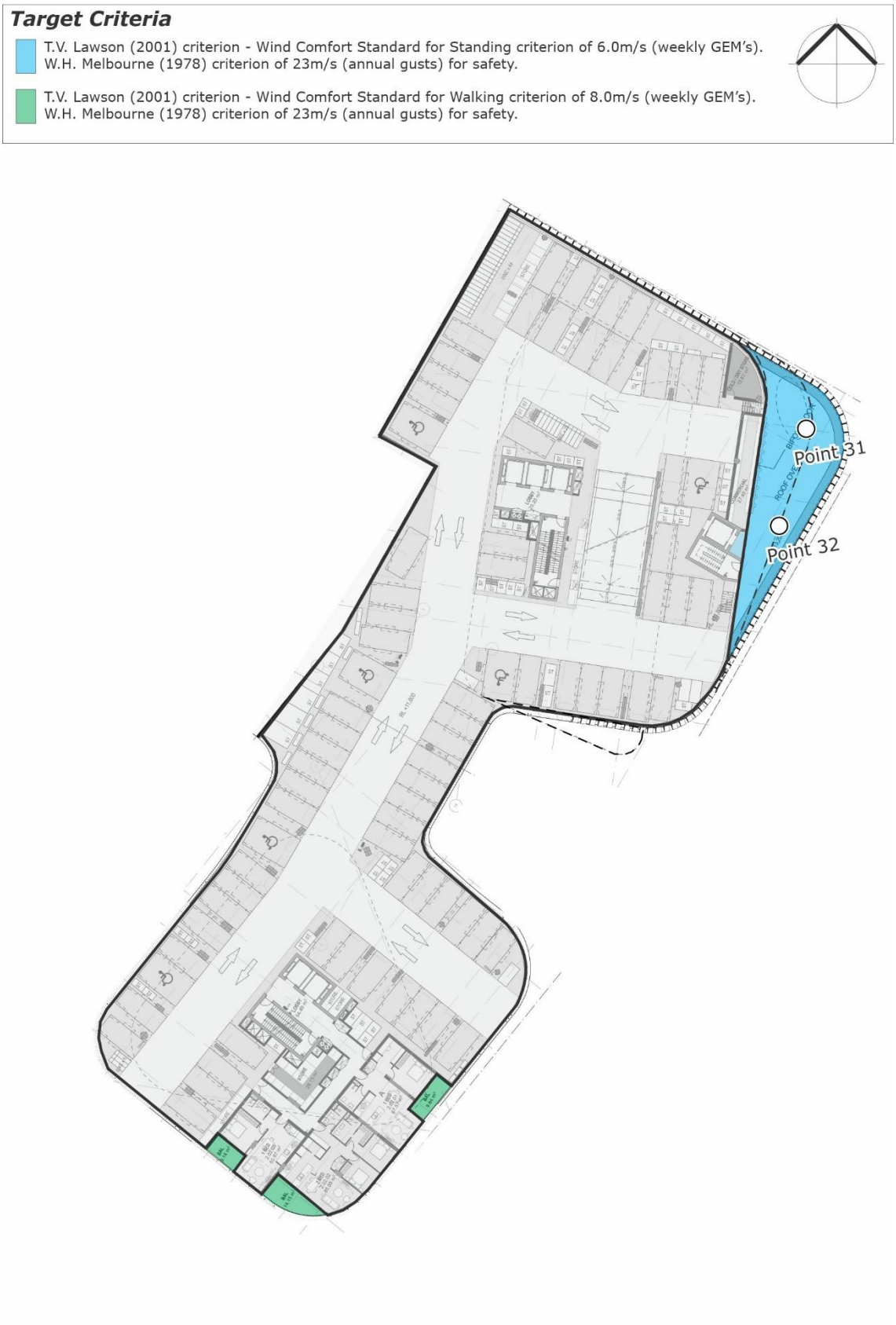

Figure 6b: Study Point Locations and Target Wind Speed Criteria – Level 02 Plan

Figure 6c: Study Point Locations and Target Wind Speed Criteria – Level 05 Plan

Figure 6d: Study Point Locations and Target Wind Speed Criteria – Level 10 Plan

Figure 6e: Study Point Locations and Target Wind Speed Criteria – Level 17 Plan

Figure 6f: Study Point Locations and Target Wind Speed Criteria – Level 21 Plan

7 RESULTS AND DISCUSSION

The results of the wind tunnel study are presented in the form of directional plots in Appendix C for all study points locations. For the Stage 1 Case, the results are summarised in Table 5, and shown on marked-up plans in Figures 7. For the Stage 2 Case, the results are summarised in Table 6, and shown on marked-up plans in Figures 8. The Existing Case results are shown on a marked-up plan in Figure 9. The wind speed criteria that the wind conditions should achieve are also listed in Table 5 for each study point location, as well as in Figures 6.

The results of the study indicate that some areas will experience strong winds which will exceed the relevant criteria for comfort and/or safety. Since the wind tunnel testing, the design of the development has been updated. The new architectural drawings/landscaping plans (received 31 October, 2022) show additional architectural/landscape elements which have been included in the design to address some of the strong wind conditions. The architectural/landscape elements shown in the updated drawings which are expected to mitigate these winds are as follows (and recommended to be retained in the final design):

Ground Level (refer to Figure 10a):

- Densely foliating evergreen tree planting along the south-western driveway, the south-western aspect of the Stage 2 Tower, the through-site link between the Stage 1 and Stage 2 Towers and the corner of Hunter Street and National Park Street.
- Impermeable wrap-around awning along the north-western, south-western and south-eastern aspects of the Stage 2 building.
- Water meter/fire booster valves along the north-eastern aspect of the Stage 1 Tower.
- Car park permeability along podium levels expected to assist in wind mitigation.

Level 02 (refer to Figure 10b):

- Dense planting, approximately 2m in height, along the northern aspect of the Level 2 communal space.

Level 05 (refer to Figure 10c):

- 1.8m high impermeable, transparent wind screens in the outdoor courtyard area on the podium level, between the Stage 1 and Stage 2 tower.
- Full-height impermeable inter-tenancy screens on the tenancies located on the Stage 2 Tower.
- Tall, densely foliating evergreen trees on the western side of the courtyard area, in-between the two towers near the turf space and to the north-east of the Stage 2 tower.
- Impermeable wrap-around awning, on the western edge and a portion of the southern and northern edges of the Stage 1 Tower.
- Impermeable awning, along the southern straight edge of the Stage 2 Tower as well as the western straight edge, eastern straight edge and northern-curved corner.

- Full-height, impermeable vertical baffle screen arrangement on the Level 05 southern balcony of the Stage 2 Tower.

Tower Levels (refer to Figures 10d and 10e):

- Full-height impermeable end screen along the north-eastern corner balcony of the Stage 1 tower, between Levels 06 to 16.
- Full-height impermeable end screen along the south-eastern corner balcony of the Stage 1 tower, between Levels 17 to 25.
- 2m high impermeable perimeter screen along the Level 17 communal terrace area on the Stage 1 tower.
- Full-height impermeable screen on the curved edge of the Stage 2 Tower western corner balcony, along Levels 14 to 25.
- Full-height impermeable screen along the south-western corner terrace of the Stage 2 tower.

It is recommended that a 3m high hoarding be included around the Stage 2 site for the duration of the construction period and until the Stage 2 development has been completed. As a general note, the use of loose glass-tops and light-weight sheets or covers (including loose BBQ lids) is not appropriate on high-rise outdoor terraces and balconies. Furthermore, lightweight furniture is not recommended unless it is securely attached to the balcony or terrace floor slab.

With the retention of the above architectural/landscape features in the final design, it is expected that wind conditions for all outdoor trafficable areas within and around the development, will be suitable for their intended uses. Nonetheless, additional wind tunnel testing is recommended to be undertaken at a more detailed design stage to quantitatively assess the wind conditions and to optimise the size and extent of the treatments required.

7.1 Stage 1 Case Results

Figure 7a: Wind Tunnel Results – Ground Floor Plan
(Stage 1 Case, results shown without treatments applied)

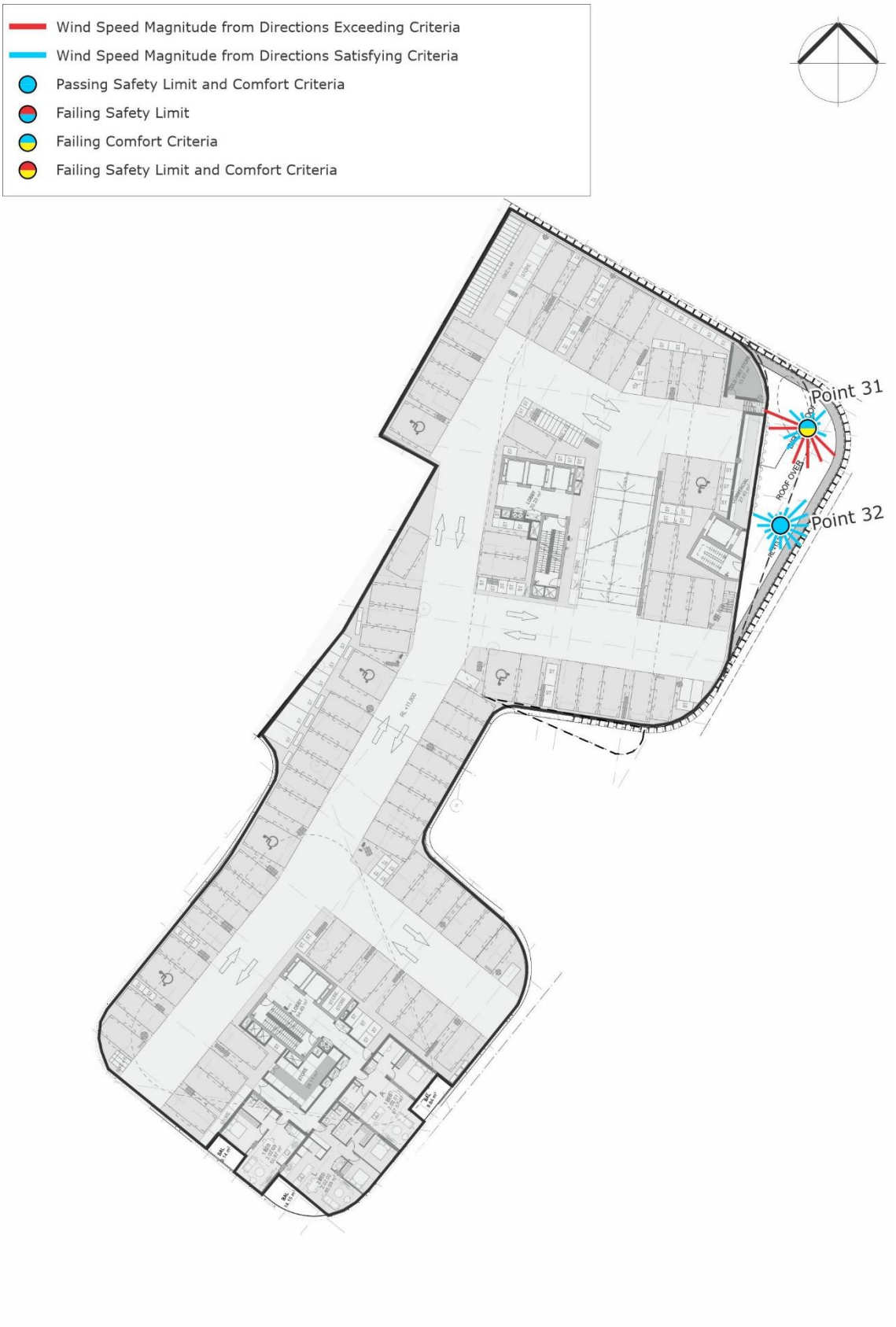

Figure 7b: Wind Tunnel Results – Level 02 Plan
(Stage 1 Case, results shown without treatments applied)

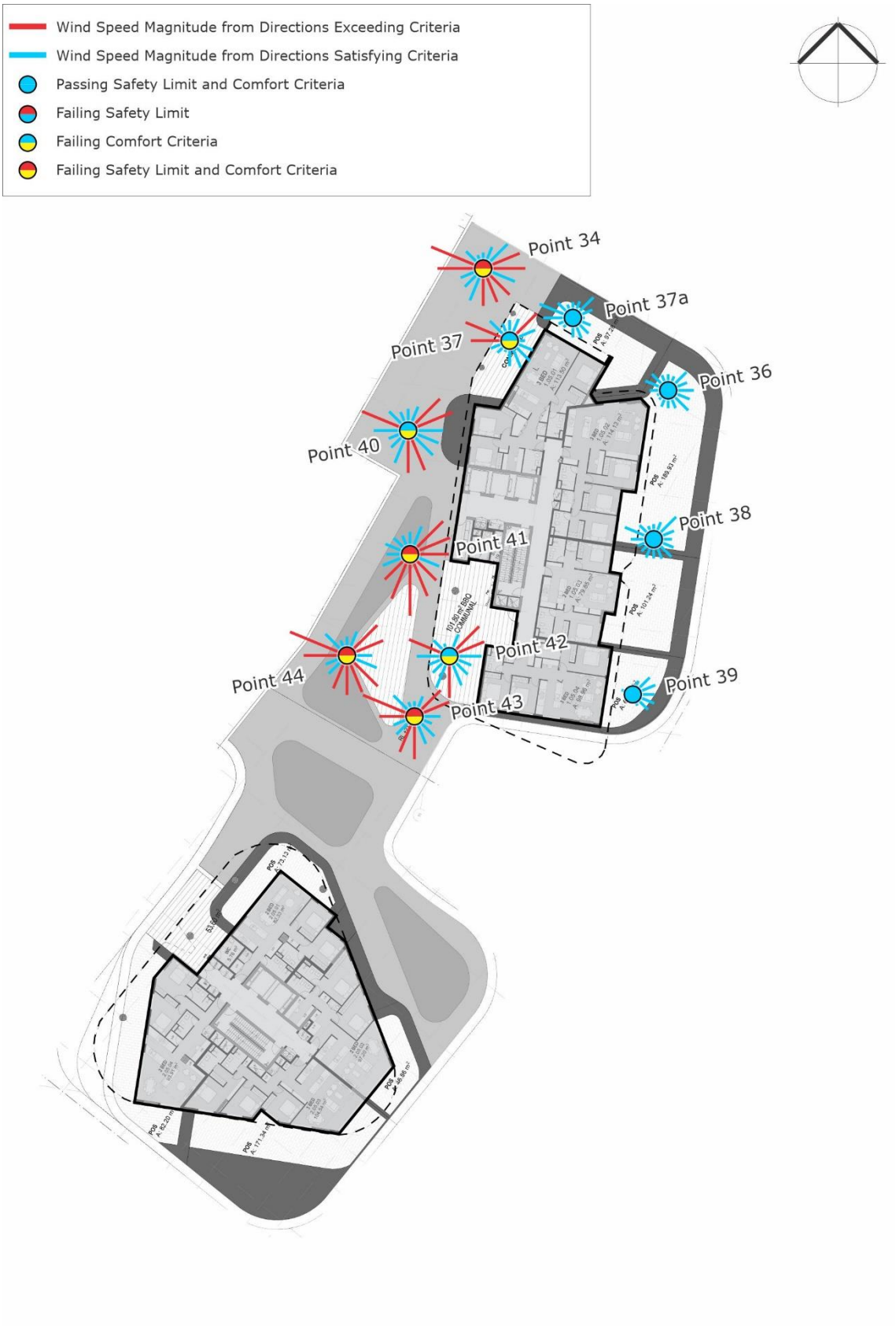

Figure 7c: Wind Tunnel Results – Level 05 Plan
(Stage 1 Case, results shown without treatments applied)

Figure 7d: Wind Tunnel Results – Level 10
(Stage 1 Case, results shown without treatments applied)

Figure 7e: Wind Tunnel Results – Level 17
(Stage 1 Case, results shown without treatments applied)

Figure 7f: Wind Tunnel Results – Level 21
(Stage 1 Case, results shown without treatments applied)

Table 5: Wind Tunnel Results Summary (Stage 1 Case)

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Point 01	8.0	10%	Fail	23	23	Pass	Fail	Refer to Figures 10a.
Existing		3%	Pass		21	Pass	Pass	
Point 02	8.0	8%	Fail	23	23	Pass	Fail	Refer to Figures 10a.
Existing		3%	Pass		21	Pass	Pass	
Point 03	6.0	23%	Fail	23	23	Pass	Fail	Refer to Figures 10a.
Existing		14%	Fail		21	Pass	Fail	
Point 04	6.0	26%	Fail	23	24	Fail	Fail	Refer to Figures 10a.
Existing		24%	Fail		23	Pass	Fail	
Point 05	8.0	9%	Fail	23	25	Fail	Fail	Refer to Figures 10a.
Existing		7%	Fail		23	Pass	Fail	
Point 06	6.0	20%	Fail	23	24	Fail	Fail	Better than or equivalent to Existing Conditions.
Existing		32%	Fail		30	Fail	Fail	
Point 07	8.0	9%	Fail	23	29	Fail	Fail	Better than or equivalent to Existing Conditions.
Existing		18%	Fail		30	Fail	Fail	
Point 08	6.0	16%	Fail	23	24	Fail	Fail	Better than or equivalent to Existing Conditions.
Existing		32%	Fail		30	Fail	Fail	
Point 09	8.0	6%	Fail	23	24	Fail	Fail	Better than or equivalent to Existing Conditions.
Existing		9%	Fail		25	Fail	Fail	
Point 10	8.0	11%	Fail	23	24	Fail	Fail	Better than or equivalent to Existing Conditions.
Existing		12%	Fail		29	Fail	Fail	
Point 11	8.0	11%	Fail	23	24	Fail	Fail	Refer to Figures 10a.
Point 12	6.0	16%	Fail	23	25	Fail	Fail	Refer to Figures 10a.
Existing		11%	Fail		19	Pass	Fail	
Point 13	8.0	3%	Pass	23	21	Pass	Pass	
Existing		6%	Fail		23	Pass	Fail	
Point 14	6.0	15%	Fail	23	21	Pass	Fail	Refer to Figures 10a.
Existing		10%	Fail		20	Pass	Fail	
Point 15	6.0	14%	Fail	23	20	Pass	Fail	Better than or equivalent to Existing Conditions.
Existing		15%	Fail		22	Pass	Fail	
Point 16	8.0	2%	Pass	23	19	Pass	Pass	
Existing		3%	Pass		22	Pass	Pass	
Point 17	8.0	1%	Pass	23	16	Pass	Pass	

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Existing		< 1%	Pass		15	Pass	Pass	
Point 18	6.0	8%	Fail	23	17	Pass	Fail	Refer to Figures 10a.
Existing		4%	Pass		15	Pass	Pass	
Point 19	8.0	< 1%	Pass	23	13	Pass	Pass	
Existing		< 1%	Pass		15	Pass	Pass	
Point 20	8.0	4%	Pass	23	19	Pass	Pass	
Point 21	8.0	7%	Fail	23	25	Fail	Fail	Refer to Figures 10a.
Point 22	8.0	7%	Fail	23	24	Fail	Fail	Refer to Figures 10a.
Point 23	6.0	17%	Fail	23	21	Pass	Fail	Better than or equivalent to Existing Conditions.
Existing		12%	Fail		20	Pass	Fail	
Point 24	6.0	13%	Fail	23	19	Pass	Fail	Better than or equivalent to Existing Conditions.
Existing		20%	Fail		24	Fail	Fail	
Point 25	8.0	3%	Pass	23	19	Pass	Pass	
Existing		1%	Pass		19	Pass	Pass	
Point 26	6.0	20%	Fail	23	22	Pass	Fail	Refer to Figures 10a.
Existing		4%	Pass		15	Pass	Pass	
Point 27	8.0	3%	Pass	23	20	Pass	Pass	
Existing		7%	Fail		26	Fail	Fail	
Point 28	8.0	3%	Pass	23	19	Pass	Pass	
Existing		5%	Pass		21	Pass	Pass	
Point 29	8.0	2%	Pass	23	21	Pass	Pass	
Existing		2%	Pass		20	Pass	Pass	
Point 30	8.0	5%	Pass	23	21	Pass	Pass	
Existing		2%	Pass		20	Pass	Pass	
Point 30a	8.0	4%	Pass	23	19	Pass	Pass	
Existing		3%	Pass		19	Pass	Pass	
Point 30b	8.0	6%	Fail	23	23	Pass	Fail	Better than or equivalent to Existing Conditions.
Existing		7%	Fail		26	Fail	Fail	
Point 31	6.0	14%	Fail	23	21	Pass	Fail	Refer to Figures 10a.
Point 32	6.0	3%	Pass	23	16	Pass	Pass	
Point 34	6.0	21%	Fail	23	25	Fail	Fail	Refer to Figures 10b.
Point 36	8.0	1%	Pass	23	18	Pass	Pass	
Point 37	6.0	10%	Fail	23	21	Pass	Fail	Refer to Figures 10c.
Point 37a	8.0	2%	Pass	23	21	Pass	Pass	

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Point 38	8.0	2%	Pass	23	19	Pass	Pass	
Point 39	8.0	< 1%	Pass	23	14	Pass	Pass	
Point 40	6.0	22%	Fail	23	22	Pass	Fail	Refer to Figures 10c.
Point 41	6.0	22%	Fail	23	24	Fail	Fail	Refer to Figures 10c.
Point 42	6.0	14%	Fail	23	19	Pass	Fail	Refer to Figures 10c.
Point 43	6.0	18%	Fail	23	24	Fail	Fail	Refer to Figures 10c.
Point 44	6.0	24%	Fail	23	27	Fail	Fail	Refer to Figures 10c.
Point 57	8.0	7%	Fail	23	28	Fail	Fail	Refer to Figures 10d.
Point 58	8.0	5%	Pass	23	24	Fail	Fail	Refer to Figures 10d.
Point 59	8.0	1%	Pass	23	17	Pass	Pass	
Point 64	6.0	15%	Fail	23	23	Pass	Fail	Refer to Figures 10e.
Point 65	6.0	23%	Fail	23	31	Fail	Fail	Refer to Figures 10e.
Point 66	8.0	2%	Pass	23	21	Pass	Pass	
Point 67	8.0	3%	Pass	23	23	Pass	Pass	
Point 68	8.0	9%	Fail	23	27	Fail	Fail	Refer to Figures 10e.

Note that, for any study points listed in Table 5 with two rows of results data, the second row is for the existing site conditions. The test results shown in Table 5 are without any treatments applied. If treatment is required, the treatment is described in Table 5.

7.2 Stage 2 Case Results

Figure 8a: Wind Tunnel Results – Ground Floor Plan
(Stage 2 Case, results shown without treatments applied)

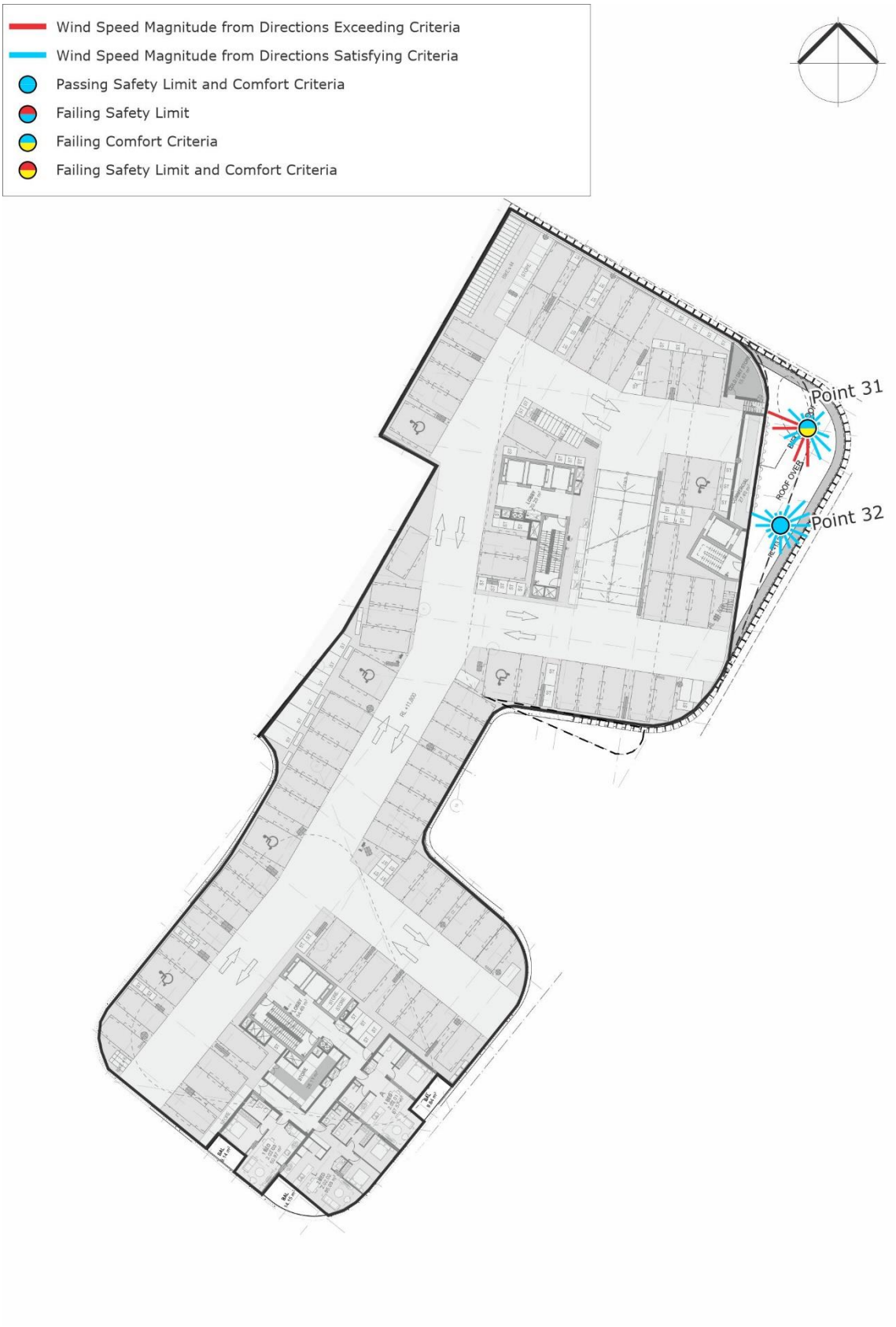

Figure 8b: Wind Tunnel Results – Level 02 Plan
(Stage 2 Case, results shown without treatments applied)

Figure 8c: Wind Tunnel Results – Level 05 Plan
(Stage 2 Case, results shown without treatments applied)

Figure 8d: Wind Tunnel Results – Level 10
(Stage 2 Case, results shown without treatments applied)

Figure 8e: Wind Tunnel Results – Level 17
(Stage 2 Case, results shown without treatments applied)

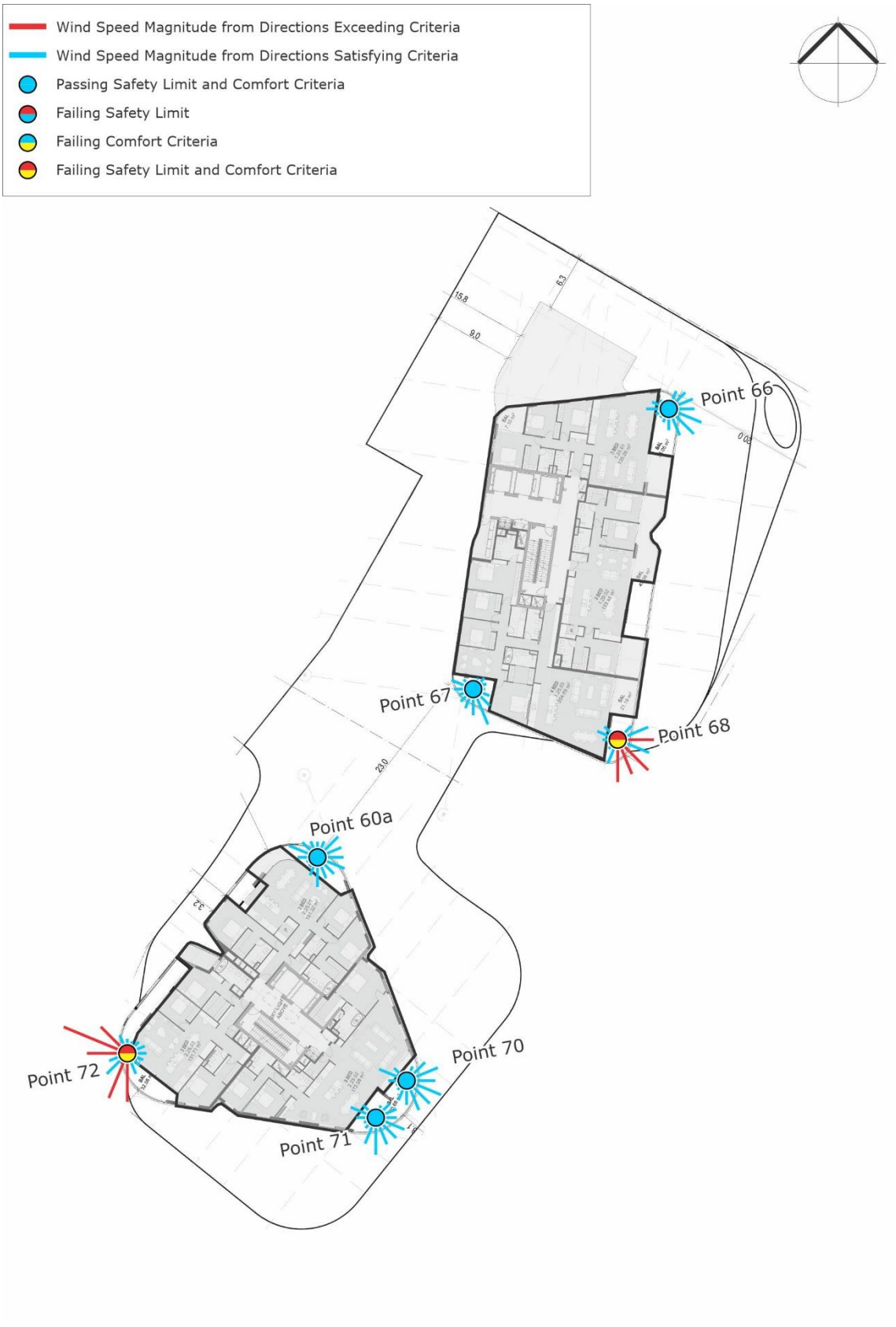

Figure 8f: Wind Tunnel Results – Level 21
(Stage 2 Case, results shown without treatments applied)

Table 6: Wind Tunnel Results Summary (Stage 2 Case)

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Point 01	8.0	10%	Fail	23	24	Fail	Fail	Refer to Figures 10a.
Existing		3%	Pass		21	Pass	Pass	
Point 02	8.0	8%	Fail	23	24	Fail	Fail	Refer to Figures 10a.
Existing		3%	Pass		21	Pass	Pass	
Point 03	6.0	18%	Fail	23	22	Pass	Fail	Refer to Figures 10a.
Existing		14%	Fail		21	Pass	Fail	
Point 04	6.0	19%	Fail	23	28	Fail	Fail	Refer to Figures 10a.
Existing		24%	Fail		23	Pass	Fail	
Point 05	8.0	4%	Pass	23	20	Pass	Pass	
Existing		7%	Fail		23	Pass	Fail	
Point 06	6.0	20%	Fail	23	25	Fail	Fail	Better than or equivalent to Existing Conditions.
Existing		32%	Fail		30	Fail	Fail	
Point 07	8.0	17%	Fail	23	27	Fail	Fail	Better than or equivalent to Existing Conditions.
Existing		18%	Fail		30	Fail	Fail	
Point 08	6.0	5%	Pass	23	17	Pass	Pass	
Existing		32%	Fail		30	Fail	Fail	
Point 09	8.0	5%	Pass	23	24	Fail	Fail	Better than or equivalent to Existing Conditions.
Existing		9%	Fail		25	Fail	Fail	
Point 10	8.0	8%	Fail	23	26	Fail	Fail	Better than or equivalent to Existing Conditions.
Existing		12%	Fail		29	Fail	Fail	
Point 11	8.0	3%	Pass	23	19	Pass	Pass	
Point 12	6.0	10%	Fail	23	17	Pass	Fail	Better than or equivalent to Existing Conditions.
Existing		11%	Fail		19	Pass	Fail	
Point 13	8.0	2%	Pass	23	19	Pass	Pass	
Existing		6%	Fail		23	Pass	Fail	
Point 14	6.0	7%	Fail	23	18	Pass	Fail	Better than or equivalent to Existing Conditions.
Existing		10%	Fail		20	Pass	Fail	
Point 15	6.0	8%	Fail	23	19	Pass	Fail	Better than or equivalent to Existing Conditions.
Existing		15%	Fail		22	Pass	Fail	
Point 16	8.0	2%	Pass	23	19	Pass	Pass	
Existing		3%	Pass		22	Pass	Pass	
Point 17	8.0	1%	Pass	23	18	Pass	Pass	
Existing		< 1%	Pass		15	Pass	Pass	
Point 18	6.0	7%	Fail	23	19	Pass	Fail	Refer to Figures 10a.
Existing		4%	Pass		15	Pass	Pass	

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Point 19	8.0	< 1%	Pass	23	15	Pass	Pass	
Existing		< 1%	Pass		15	Pass	Pass	
Point 20	8.0	2%	Pass	23	20	Pass	Pass	
Point 21	8.0	7%	Fail	23	25	Fail	Fail	Refer to Figures 10a.
Point 22	8.0	7%	Fail	23	24	Fail	Fail	Refer to Figures 10a.
Point 23	6.0	3%	Pass	23	15	Pass	Pass	
Existing		12%	Fail		20	Pass	Fail	
Point 24	6.0	23%	Fail	23	24	Fail	Fail	Refer to Figures 10a.
Existing		20%	Fail		24	Fail	Fail	
Point 25	8.0	1%	Pass	23	19	Pass	Pass	
Existing		1%	Pass		19	Pass	Pass	
Point 26	6.0	26%	Fail	23	33	Fail	Fail	Refer to Figures 10a.
Existing		4%	Pass		15	Pass	Pass	
Point 27	8.0	8%	Fail	23	25	Fail	Fail	Better than or equivalent to Existing Conditions.
Existing		7%	Fail		26	Fail	Fail	
Point 28	8.0	5%	Pass	23	21	Pass	Pass	
Existing		5%	Pass		21	Pass	Pass	
Point 29	8.0	3%	Pass	23	21	Pass	Pass	
Existing		2%	Pass		20	Pass	Pass	
Point 30	8.0	6%	Fail	23	24	Fail	Fail	Refer to Figures 10a.
Existing		2%	Pass		20	Pass	Pass	
Point 30a	8.0	4%	Pass	23	18	Pass	Pass	
Existing		3%	Pass		19	Pass	Pass	
Point 30b	8.0	7%	Fail	23	23	Pass	Fail	Better than or equivalent to Existing Conditions.
Existing		7%	Fail		26	Fail	Fail	
Point 31	6.0	10%	Fail	23	18	Pass	Fail	Refer to Figures 10b.
Point 32	6.0	4%	Pass	23	16	Pass	Pass	
Point 34	6.0	17%	Fail	23	27	Fail	Fail	Refer to Figures 10c.
Point 36	8.0	1%	Pass	23	16	Pass	Pass	
Point 37	6.0	9%	Fail	23	23	Pass	Fail	Refer to Figures 10c.
Point 37a	8.0	2%	Pass	23	23	Pass	Pass	
Point 38	8.0	1%	Pass	23	18	Pass	Pass	
Point 39	8.0	< 1%	Pass	23	13	Pass	Pass	
Point 40	6.0	17%	Fail	23	22	Pass	Fail	Refer to Figures 10c.
Point 41	6.0	18%	Fail	23	19	Pass	Fail	Refer to Figures 10c.
Point 42	6.0	14%	Fail	23	19	Pass	Fail	Refer to Figures 10c.
Point 43	6.0	15%	Fail	23	27	Fail	Fail	Refer to Figures 10c.

Study Point	GEM (5% exceedance)			Annual Gust			Final Result	Description of Treatment
	Criterion (m/s)	Results (%)	Grade	Criterion (m/s)	Results (m/s)	Grade		
Point 44	6.0	26%	Fail	23	30	Fail	Fail	Refer to Figures 10c.
Point 45	6.0	22%	Fail	23	30	Fail	Fail	Refer to Figures 10c.
Point 46	6.0	26%	Fail	23	32	Fail	Fail	Refer to Figures 10c.
Point 47	6.0	27%	Fail	23	27	Fail	Fail	Refer to Figures 10c.
Point 48	8.0	18%	Fail	23	36	Fail	Fail	Refer to Figures 10c.
Point 49	6.0	25%	Fail	23	32	Fail	Fail	Refer to Figures 10c.
Point 50	6.0	20%	Fail	23	27	Fail	Fail	Refer to Figures 10c.
Point 51	8.0	16%	Fail	23	27	Fail	Fail	Refer to Figures 10c.
Point 52	8.0	18%	Fail	23	28	Fail	Fail	Refer to Figures 10c.
Point 54	8.0	20%	Fail	23	32	Fail	Fail	Refer to Figures 10c.
Point 55	8.0	12%	Fail	23	36	Fail	Fail	Refer to Figures 10c.
Point 57	8.0	7%	Fail	23	27	Fail	Fail	Refer to Figures 10d.
Point 58	8.0	5%	Pass	23	23	Pass	Pass	
Point 59	8.0	3%	Pass	23	22	Pass	Pass	
Point 60	8.0	2%	Pass	23	18	Pass	Pass	
Point 60a	8.0	2%	Pass	23	18	Pass	Pass	
Point 61	8.0	3%	Pass	23	20	Pass	Pass	
Point 62	8.0	3%	Pass	23	21	Pass	Pass	
Point 63	8.0	4%	Pass	23	23	Pass	Pass	
Point 64	6.0	18%	Fail	23	23	Pass	Fail	Refer to Figures 10e.
Point 65	6.0	24%	Fail	23	29	Fail	Fail	Refer to Figures 10e.
Point 66	8.0	2%	Pass	23	22	Pass	Pass	
Point 67	8.0	2%	Pass	23	22	Pass	Pass	
Point 68	8.0	9%	Fail	23	27	Fail	Fail	Refer to Figures 10e.
Point 70	8.0	4%	Pass	23	21	Pass	Pass	
Point 71	8.0	3%	Pass	23	22	Pass	Pass	
Point 72	8.0	20%	Fail	23	35	Fail	Fail	Refer to Figures 10e.

Note that, for any study points listed in Table 6 with two rows of results data, the second row is for the existing site conditions. The test results shown in Table 6 are without any treatments applied. If treatment is required, the treatment is described in Table 6.

7.3 Existing Case Results

Figure 9: Wind Tunnel Results – Ground Floor Plan
(Existing Case, results shown without treatments applied)

7.4 Wind Mitigation Measures

Figure 10a: Suggested Retention of Architectural/Landscape Elements – Ground Level Plan

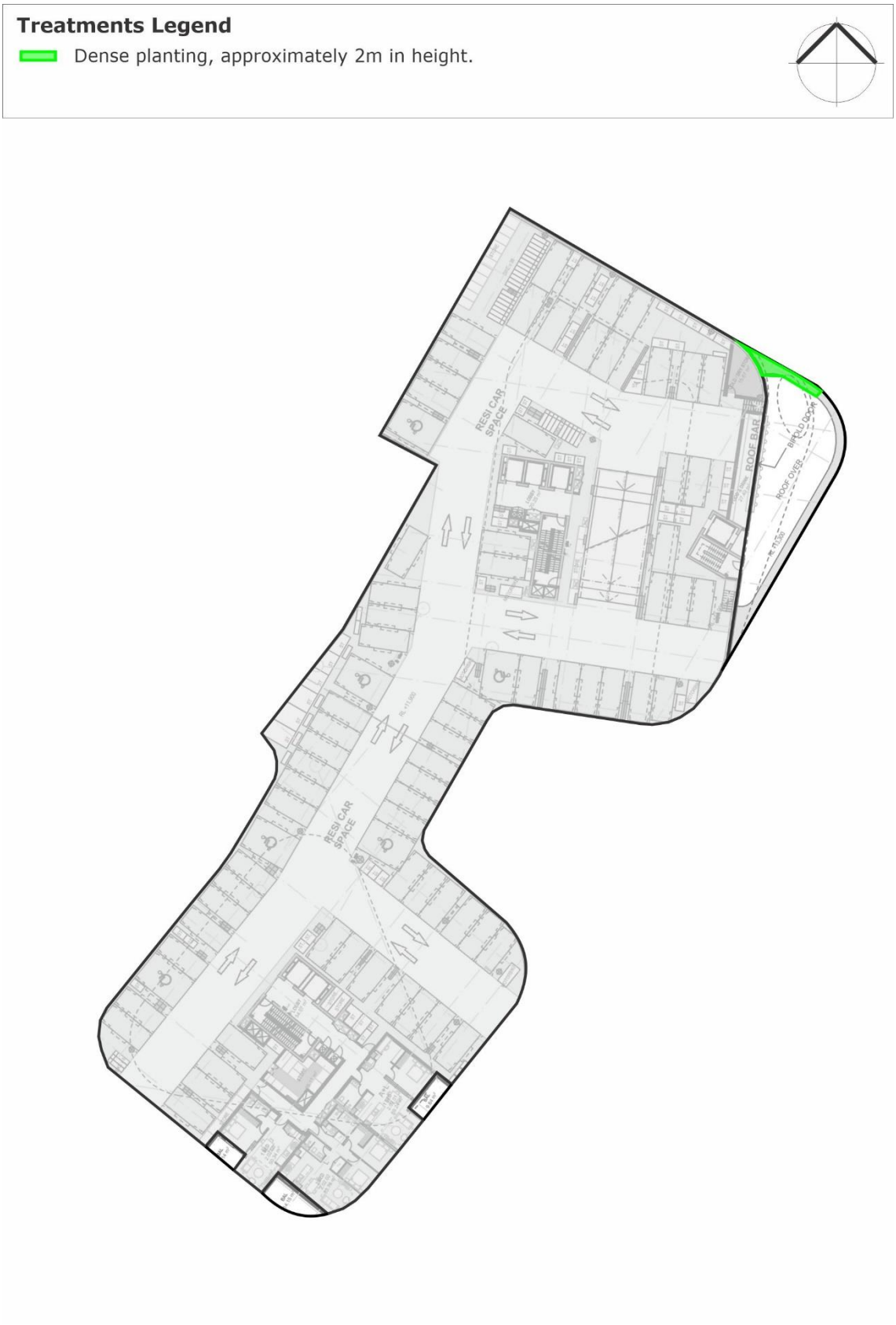

Figure 10b: Suggested Retention of Architectural/Landscape Elements – Level 02 Plan

Figure 10c: Suggested Retention of Architectural/Landscape Elements – Level 05 Plan

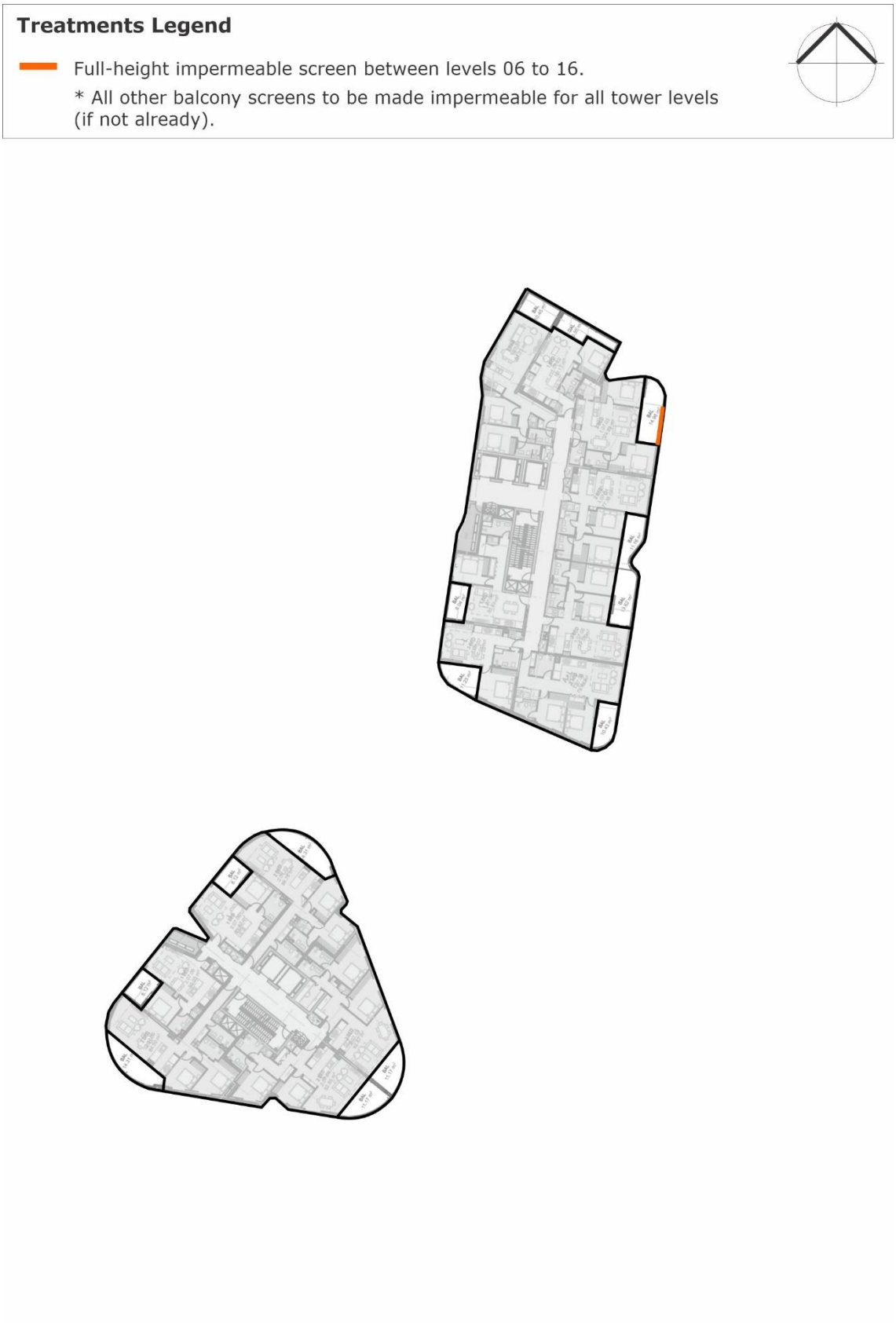

Figure 10d: Suggested Retention of Architectural/Landscape Elements – Level 10

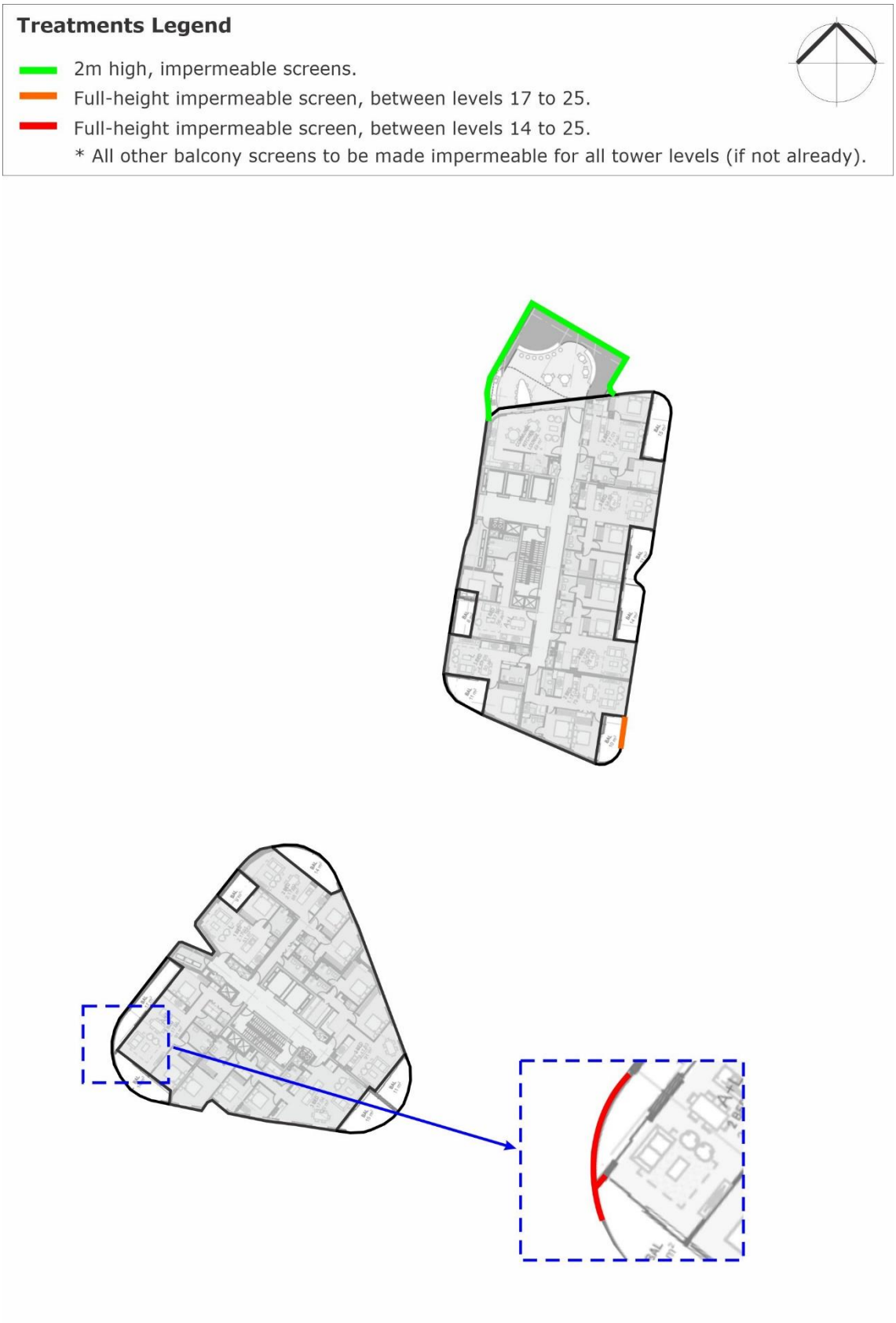

Figure 10e: Suggested Retention of Architectural/Landscape Elements – Level 17

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APPENDIX A PUBLISHED ENVIRONMENTAL CRITERIA

A.1 Wind Effects on People

The acceptability of wind in an area is dependent upon the use of the area. For example, people walking or window-shopping will tolerate higher wind speeds than those seated at an outdoor restaurant. Quantifying wind comfort has been the subject of much research and many researchers, such as A.G. Davenport, T.V. Lawson, W.H. Melbourne, and A.D. Penwarden, have published criteria for pedestrian comfort for pedestrians in outdoor spaces for various types of activities. This section discusses and compares the various published criteria.

A.2 A.D. Penwarden (1973) Criteria for Mean Wind Speeds

A.D. Penwarden (1973) developed a modified version of the Beaufort scale which describes the effects of various wind intensities on people. Table A.1 presents the modified Beaufort scale. Note that the effects listed in this table refers to wind conditions occurring frequently over the averaging time (a probability of occurrence exceeding 5%). Higher ranges of wind speeds can be tolerated for rarer events.

Table A.1: Summary of Wind Effects on People (A.D. Penwarden, 1973)

Type of Winds	Beaufort Number	Hourly Mean Wind Speed (m/s)	Effects
Calm	0	0 - 0.3	
Calm, light air	1	0.3 - 1.6	No noticeable wind
Light breeze	2	1.6 - 3.4	Wind felt on face
Gentle breeze	3	3.4 - 5.5	Hair is disturbed, clothing flaps, newspapers difficult to read
Moderate breeze	4	5.5 – 8.0	Raises dust, dry soil and loose paper, hair disarranged
Fresh breeze	5	8.0 – 10.8	Force of wind felt on body, danger of stumbling
Strong breeze	6	10.8 – 13.9	Umbrellas used with difficulty, hair blown straight, difficult to walk steadily, wind noise on ears unpleasant
Near gale	7	13.9 – 17.2	Inconvenience felt when walking
Gale	8	17.2 - 20.8	Generally impedes progress, difficulty balancing in gusts
Strong gale	9	20.8 – 24.5	People blown over

A.3 A.G. Davenport (1972) Criteria for Mean Wind Speeds

A.G. Davenport (1972) also determined a set of criteria in terms of the Beaufort scale and for various return periods. Table A.2 presents a summary of the criteria based on a probability of exceedance of 5%.

Table A.2: Criteria by A.G. Davenport (1972)

Classification	Activities	5% exceedance Mean Wind Speed (m/s)
Walking Fast	Acceptable for walking, main public accessways.	7.5 - 10.0
Strolling, Skating	Slow walking, etc.	5.5 - 7.5
Short Exposure Activities	Generally acceptable for walking & short duration stationary activities such as window-shopping, standing or sitting in plazas.	3.5 - 5.5
Long Exposure Activities	Generally acceptable for long duration stationary activities such as in outdoor restaurants & theatres and in parks.	0 - 3.5

A.4 T.V. Lawson (1975) Criteria for Mean Wind Speeds

In 1973, T.V. Lawson, while referring to the Beaufort wind speeds of A.D. Penwarden (1973) (as listed in Table A.1), quoted that a Beaufort 4 wind speed would be acceptable if it is not exceeded for more than 4% of the time, and that a Beaufort 6 wind speed would be unacceptable if it is exceeded more than 2% of the time. Later, in 1975, T.V. Lawson presented a set of criteria very similar to those presented in A.G. Davenport (1972) (as listed in Table A.2). These criteria are presented in Table A.3 and Table A.4 for safety and comfort respectively.

Table A.3: Safety Criteria by T.V. Lawson (1975)

Classification	Activities	Annual Mean Wind Speed (m/s)
Safety (all weather areas)	Accessible by the general public.	0 – 15
Safety (fair weather areas)	Private areas, balconies/terraces, etc.	0 – 20

Table A.4: Comfort Criteria by T.V. Lawson (1975)

Classification	Activities	5% exceedance Mean Wind Speed (m/s)
Business Walking	Objective Walking from A to B.	8 - 10
Pedestrian Walking	Slow walking, etc.	6 - 8
Short Exposure Activities	Pedestrian standing or sitting for short times.	4 – 6
Long Exposure Activities	Pedestrian sitting for a long duration.	0 - 4

A.5 W.H. Melbourne (1978) Criteria for Gust Wind Speeds

W.H. Melbourne (1978) introduced a set of criteria for the assessment of environmental wind conditions that were developed for a temperature range of 10°C to 30°C and for people suitably dressed for outdoor conditions. These criteria are presented in Table A.5, and are based on maximum gust wind speeds with a probability of exceedance of once per year.

Table A.5: Criteria by W.H. Melbourne (1978)

Classification	Activities	Annual Gust Wind Speed (m/s)
Limit for Safety	Completely unacceptable: people likely to get blown over.	23
Marginal	Unacceptable as main public accessways.	16 - 23
Comfortable Walking	Acceptable for walking, main public accessways	13 - 16
Short Exposure Activities	Generally acceptable for walking & short duration stationary activities such as window-shopping, standing or sitting in plazas.	10 - 13
Long Exposure Activities	Generally acceptable for long duration stationary activities such as in outdoor restaurants & theatres and in parks.	0 - 10

A.6 Comparison of the Published Wind Speed Criteria

W.H. Melbourne (1978) presented a comparison of the criteria of various researchers on a probabilistic basis. Figure A.1 presents the results of this comparison, and indicates that the criteria of W.H. Melbourne (1978) are comparatively quite conservative. This conclusion was also observed by A.W. Rofail (2007) when undertaking on-site remedial studies. The results of A.W. Rofail (2007) concluded that the criteria by W.H. Melbourne (1978) generally overstates the wind effects in a typical urban setting due to the assumption of a fixed 15% turbulence intensity for all areas. It was observed in A.W. Rofail (2007) that the 15% turbulence intensity assumption is not real and that the turbulence intensities at 1.5m above ground is at least 20% and in a suburban or urban setting is generally in the range of 30% to 60%.

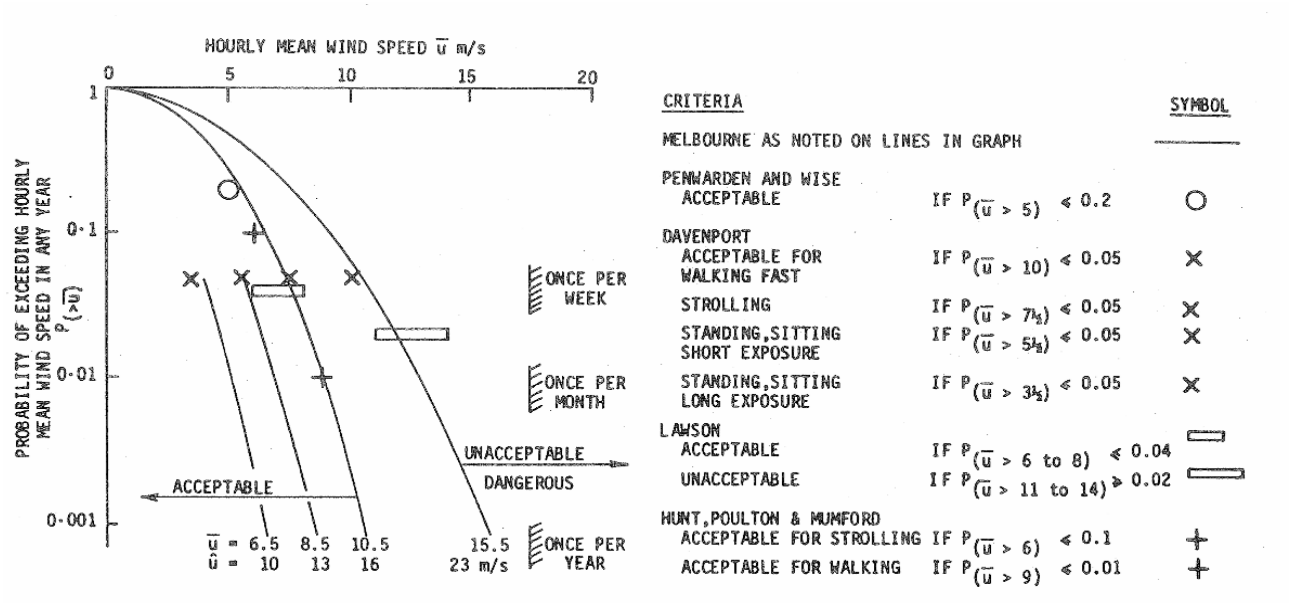


Figure A.1: Comparison of Various Mean and Gust Wind Environment Criteria, assuming 15% turbulence and a Gust Factor of 1.5 (W.H. Melbourne, 1978)

A.7 References relating to Pedestrian Comfort Criteria

Davenport, A.G., 1972, "An approach to human comfort criteria for environmental conditions". Colloquium on Building Climatology, Stockholm.

Davenport, A.G., 1977, "The prediction of risk under wind loading", 2nd International Conference on Structural Safety and Reliability, Munich, Germany, pp511-538.

Lawson, T.V., 1973, "The wind environment of buildings: a logical approach to the establishment of criteria". Bristol University, Department of Aeronautical Engineering.

Lawson, T.V., 1975, "The determination of the wind environment of a building complex before construction". Bristol University, Department of Aeronautical Engineering.

Melbourne, W.H., 1978, "Criteria for Environmental Wind Conditions". Journal of Wind Engineering and Industrial Aerodynamics, vol. 3, pp241-249.

Penwarden, A.D. (1973). "Acceptable Wind Speeds in Towns", Building Science, vol. 8: pp259–267.

Penwarden, A.D., Wise A.F.E., 1975, "Wind Environment Around Buildings". Building Research Establishment Report, London.

Rofail, A.W., 2007, "Comparison of Wind Environment Criteria against Field Observations". 12th International Conference of Wind Engineering, Cairns, Australia.

APPENDIX B DATA ACQUISITION

The wind tunnel testing procedures utilised for this study were based on the guidelines set out in the Australasian Wind Engineering Society Quality Assurance Manual (AWES-QAM-1-2019), ASCE 7-16 (Chapter C31), and CTBUH (2013). The wind speed measurements for the wind tunnel study were determined as coefficients using data acquired by either Dantec hot-wire probe anemometers or pressure-based wind speed sensors and converted to full-scale wind speeds using details of the regional wind climate obtained from an analysis of directional wind speed recordings from the local meteorological recording station(s).

B.1 Measurement of the Velocity Coefficients

The study model and proximity model were setup within the wind tunnel which was configured to the appropriate boundary layer profile, and the wind velocity measurements were monitored using either Dantec hot-wire probe anemometers or pressure-based wind speed sensors at selected critical outdoor locations. The wind velocity results presented in this study for each study point are representative of wind at a full-scale height of approximately 1.5m above ground/slab level. In the case of the Dantec hot-wire probe anemometers, the support of the probe is mounted such that the probe wire is vertical as much as possible to ensure that the measured wind speeds are independent of wind direction along the horizontal plane. In addition, care was taken in the alignment of the hot-wire probe wire and in avoiding wall-heating effects.

Wind speed measurements were made in the wind tunnel for 16 wind directions, at 22.5° increments. Data was acquired for each wind direction using a sample rate of 1024Hz. The sample length was determined to produce a full-scale sample time that is sufficient for this type of study. In the case of the pressure-based wind speed sensors, the phase lag between the various channels where data is acquired simultaneously is within 10% of a typical pressure cycle, and the signal is low-pass filtered at 500Hz and then digital filtering is applied over this range to provide an unbiased response from the pressure measurement system (A.W. Rofail, 2004).

The mean, gust and standard deviation velocity coefficients were determined from the data acquired in the wind tunnel. The gust velocity coefficients were also derived for each wind direction from by the following relation:

$$\hat{C}_V = \bar{C}_V + g \cdot \sigma_{C_V} \qquad \text{B.1}$$

where:

$\hat{C}_V$ is the gust velocity coefficient.

$\bar{C}_V$ is the mean velocity coefficient.

g is the peak factor, taken as 3.0 for a 3-sec gust and 3.4 for a 0.5-sec gust.

σ_{C_V} is the standard deviation of the velocity coefficient measurement.

In the case of a Dantec hot-wire probe anemometer, the velocity coefficient is obtained as follows:

$$C_V = \frac{C_{V,study}}{C_{V,200m}} \quad \text{B.2}$$

where:

$C_{V,study}$ is the velocity coefficient measurement obtained from the Dantec hot-wire probe anemometer at the study point location.

$C_{V,200m}$ is the velocity coefficient measurement obtained from the Dantec hot-wire probe anemometer at the free-stream reference location at 200m height upwind of the model in the wind tunnel.

However, in the case of the pressure-based wind speed sensors, these are determined from the measured differential mean, standard deviation and maximum pressure coefficients obtained from the wind speed sensor. For this analysis all calculations are performed on the square root of the differential pressure measurements. The velocity coefficient at the pressure-based wind speed sensor location is then calculated as follows:

$$C_V = \frac{\alpha + \beta\sqrt{\Delta p}}{V_{200m}} \quad \text{B.3}$$

where:

C_V is the velocity coefficient measurement at the study point location.

α is a calibration coefficient for the pressure-based wind speed sensor.

β is a calibration coefficient for the pressure-based wind speed sensor.

Δp is the differential pressure obtained from the pressure-based wind speed sensor at the study point location.

V_{200m} is the wind speed at the free-stream reference location of 200m height (full-scale) in the wind tunnel, which is determined directly in the wind tunnel using a pitot static probe.

B.2 Calculation of the Full-Scale Results

The full-scale results determine if the wind conditions at a study location satisfy the designated criteria of that location. More specifically, the full-scale results need to determine the probability of exceedance of a given wind speed at a study location. To determine the probability of exceedance, the measured velocity coefficients were combined with a statistical model of the local wind climate that relates wind speed to a probability of exceedance. Details of the wind climate model are outlined in Section 5 of the main report.

The statistical model of the wind climate includes the impact of wind directionality as any local variations in wind speed or frequency with wind direction. This is important as the wind directions that produce the highest wind speed events for a region may not coincide with the most wind exposed direction at the site.

The methodology adopted for the derivation of the full-scale results for the maximum gust and the GEM wind speeds are outlined in the following sub-sections.

B.3 Maximum Gust Wind Speeds

The full-scale maximum gust wind speed at each study point location is derived from the velocity coefficient using the following relationship:

$$V_{study} = V_{ref,RH}\left(\frac{k_{200m,tr,T=1hr}}{k_{RH,tr,T=1hr}}\right)C_V \qquad \text{B.4}$$

where:

V_{study} is the full-scale wind speed at the study point location.

$V_{ref,RH}$ is the full-scale reference wind speed at the study reference height. This value is determined by combining the directional wind speed data for the region (detailed in Section 5) and the upwind terrain and height multipliers for the site (detailed in Section 4).

$k_{200m,tr,T=1hr}$ is the hourly mean terrain and height multiplier at the free-stream reference location of 200m height.

$k_{RH,tr,T=1hr}$ is the hourly mean terrain and height multiplier at the study reference height (Section 4).

C_V is the velocity coefficient, obtained from either Equation B.2 (in the case of Dantec hot-wire probe anemometers) or Equation B.3 (in the case of pressure-based wind speed sensors).

The value of $V_{ref,RH}$ varies with each prevailing wind direction. Wind directions where there is a high probability that a strong wind will occur have a higher directional wind speed than other directions. To determine the directional wind speeds, a probability level must be assigned for each wind direction. These probability levels are set following the approach used in AS/NZS1170.2:2011, which assumes that the major contributions to the combined probability of exceedance of a typical load effect comes from only two 45 degree sectors.

B.4 Maximum Gust-Equivalent Mean Wind Speeds

The contribution to the probability of exceedance of a specified wind speed (ie: the desired wind speed for pedestrian comfort, as per the criteria) was calculated for each wind direction. These contributions are then combined over all wind directions to calculate the total probability of exceedance of the specified wind speed. To calculate the probability of exceedance for a specified wind speed a statistical wind climate model was used to describe the relationship between directional wind speeds and the probability of exceedance. A detailed description of the methodology is given by T.V. Lawson (1980).

The criteria used in this study is referenced to a probability of exceedance of 5% of a specified wind speed.

B.5 References relating to Data Acquisition

American Society of Civil Engineers (ASCE), ASCE-7-16, 2016, "Minimum Design Loads for Buildings and Other Structures".

Australasian Wind Engineering Society, QAM-1, 2019, "Quality Assurance Manual: Wind Engineering Studies of Buildings", edited by Rofail A.W., et al.

Council on Tall Buildings and Urban Habitat (CTBUH), 2013, "Wind tunnel testing of high-rise buildings", CTBUH Technical Guides.

Lawson, T.V., 1980, "Wind Effects on Buildings - Volume 1, Design Applications". Applied Science Publishers Ltd, Ripple Road, Barking, Essex, England.

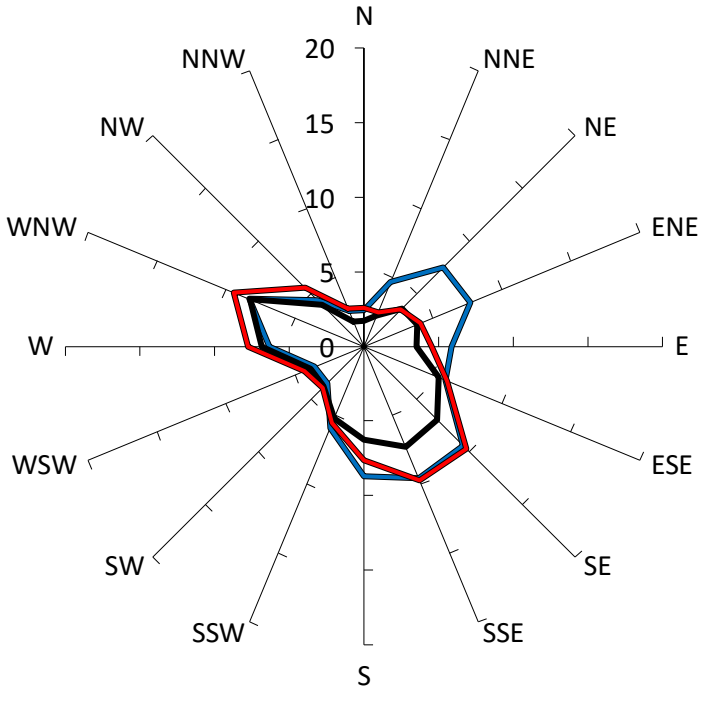
Rofail A.W., Tonin, R., and Hanafi, D., 2004, "Sensitivity of frequency response to type of tubing", Australasian Wind Engineering Workshop, Darwin.

Standards Australia and Standards New Zealand, AS/NZS 1170.2, 2011, "SAA Wind Loading Standard, Part 2: Wind Actions".

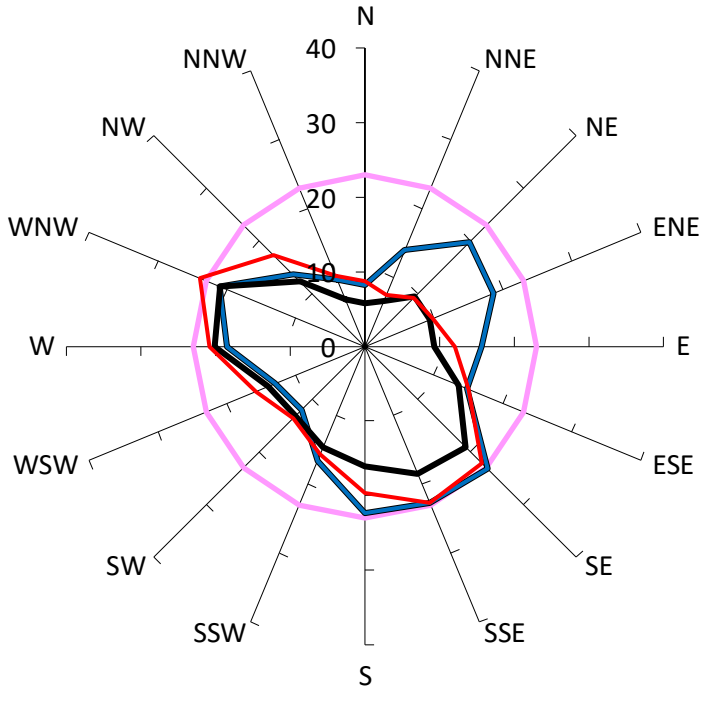
APPENDIX C DIRECTIONAL PLOTS OF WIND TUNNEL RESULTS

Results for Point 01

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

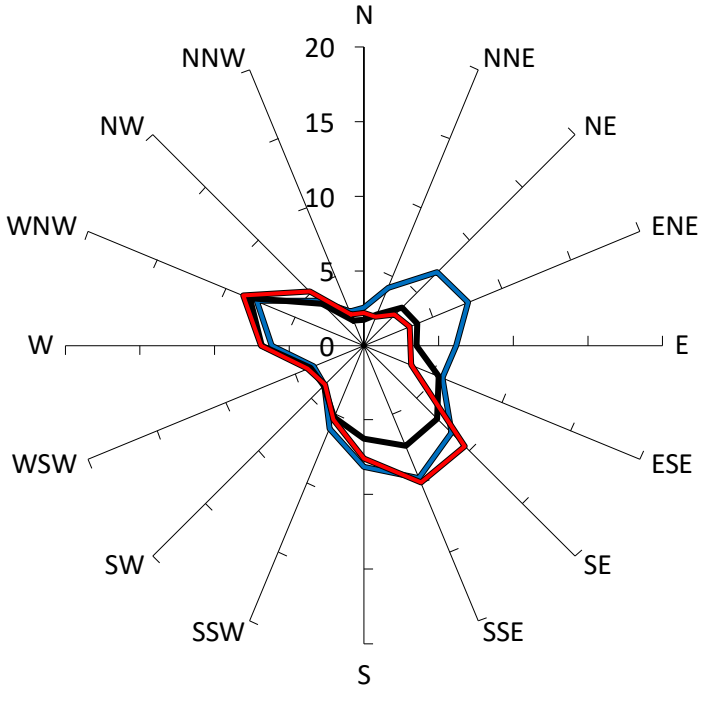


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	10%	23
Existing Case.	3%	21
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	10%	24

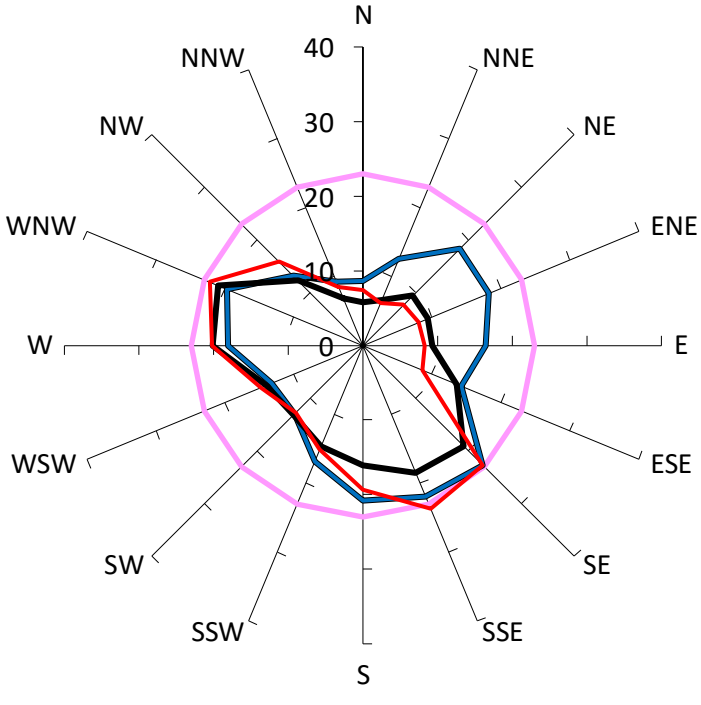
Results for Point 02

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

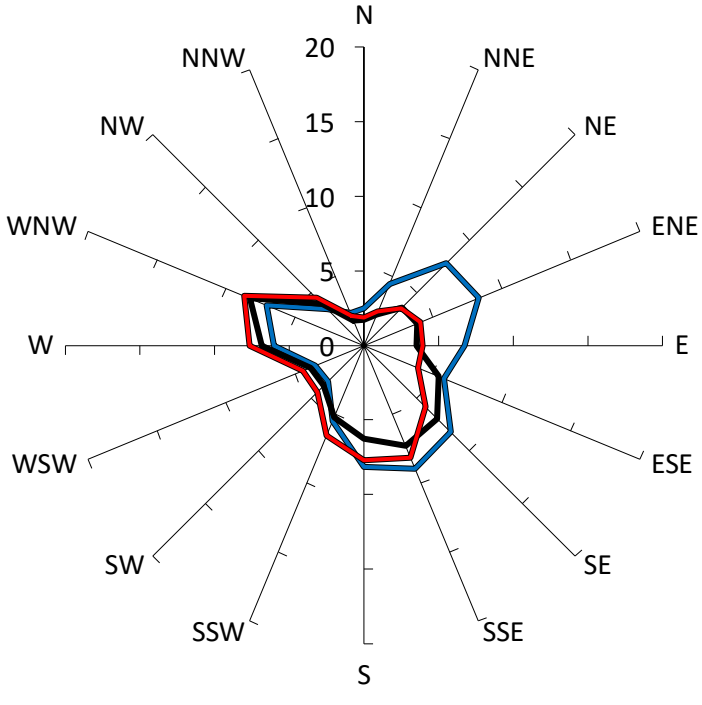


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	8%	23
Existing Case.	3%	21
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	8%	24

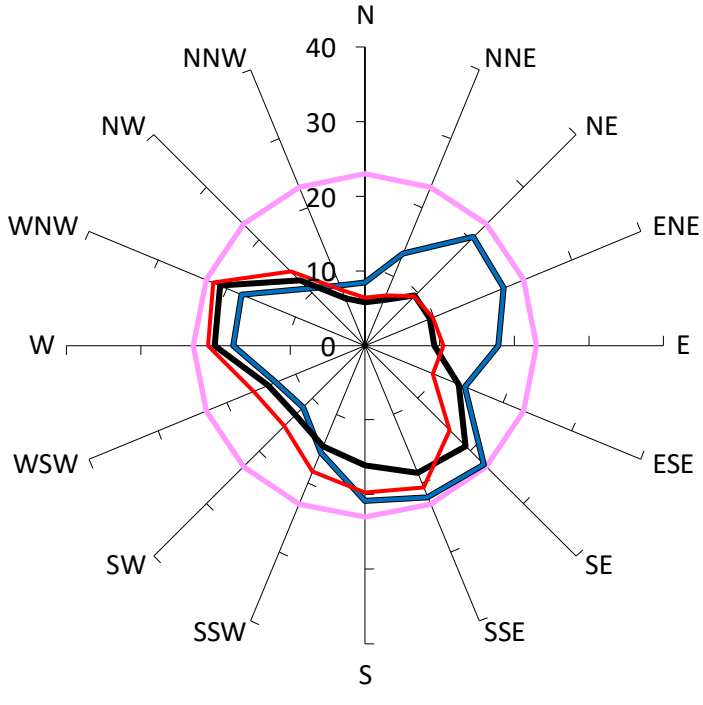
Results for Point 03

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

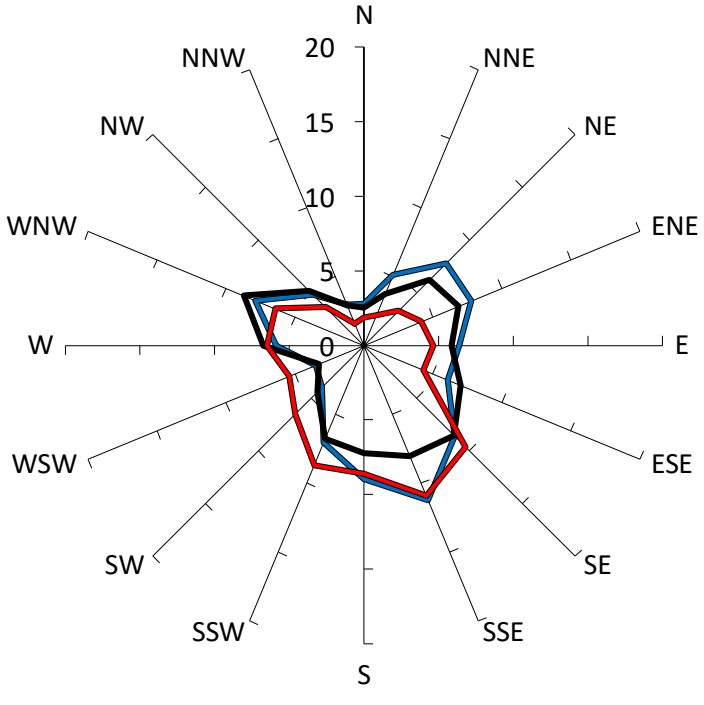


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	23%	23
Existing Case.	14%	21
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	18%	22

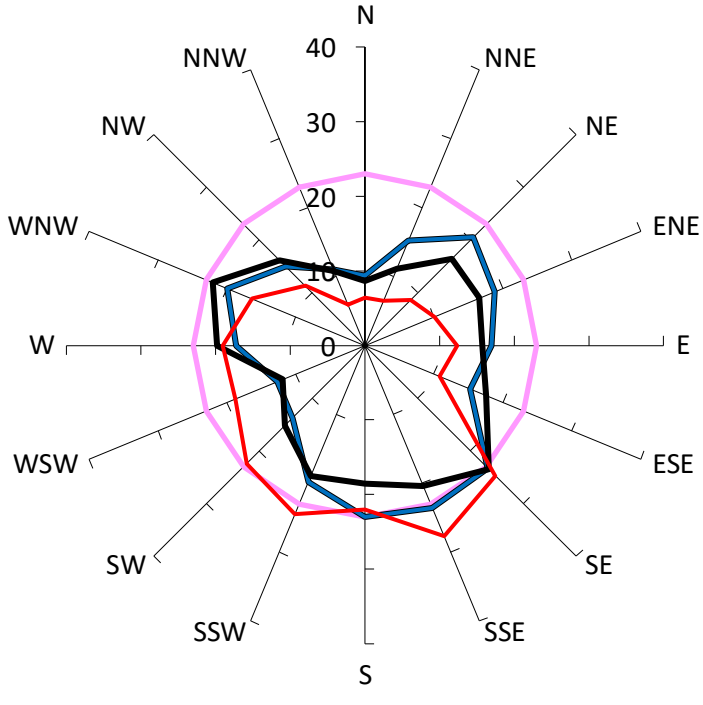
Results for Point 04

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

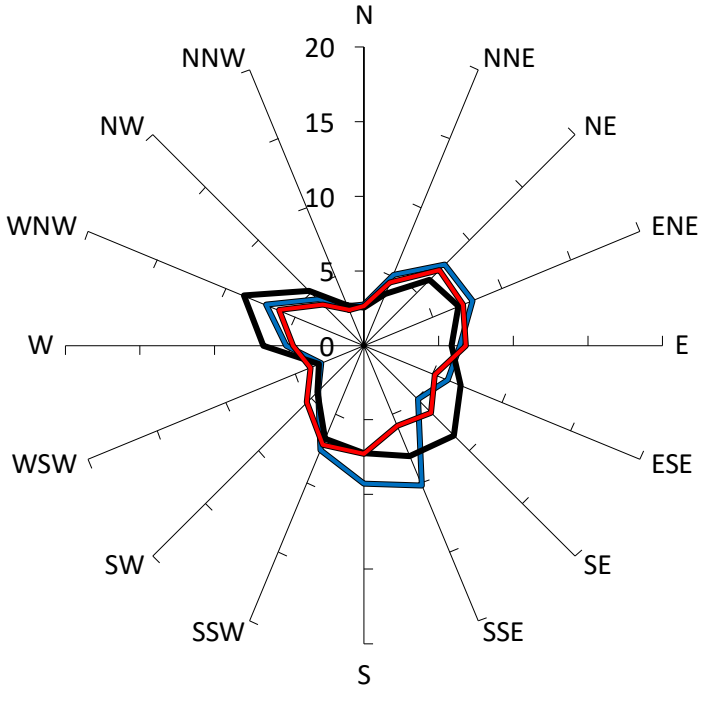


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	26%	24
Existing Case.	24%	23
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	19%	28

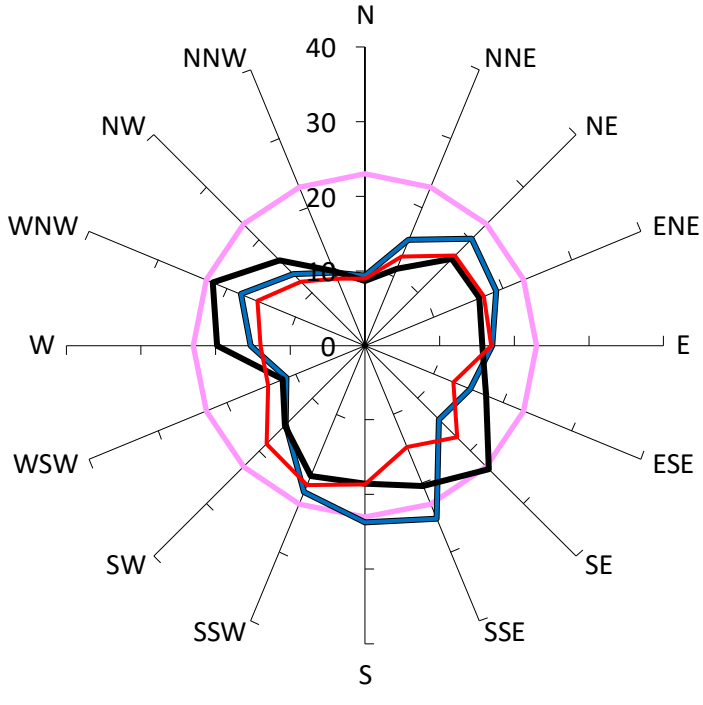
Results for Point 05

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

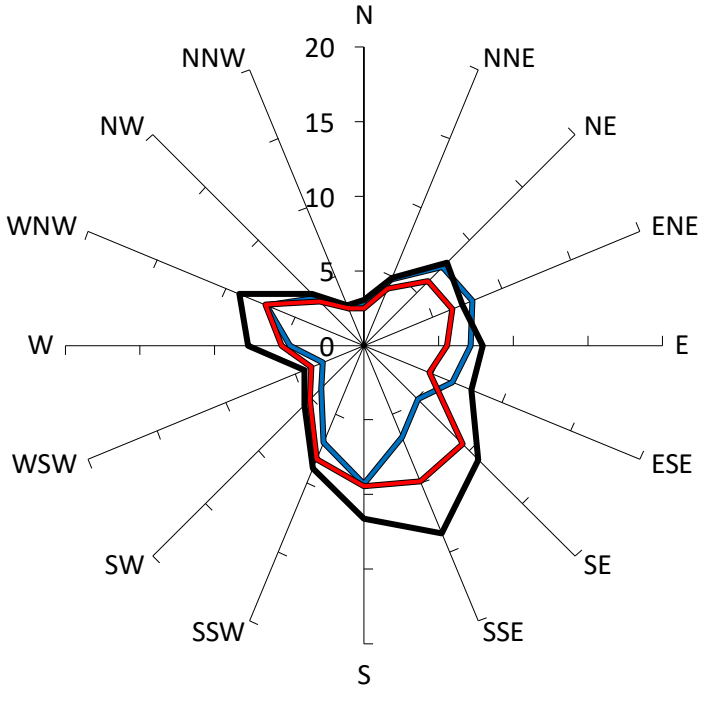


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	9%	25
Existing Case.	7%	23
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	4%	20

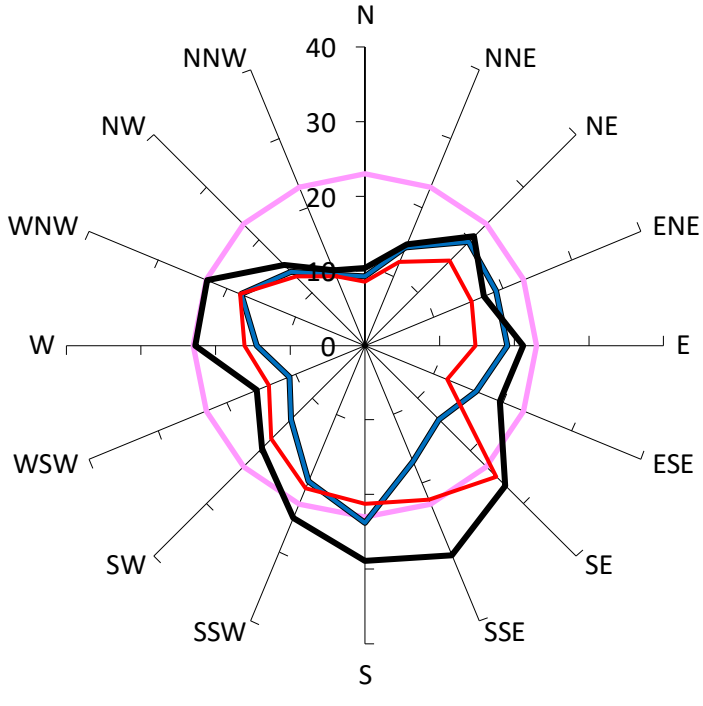
Results for Point 06

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

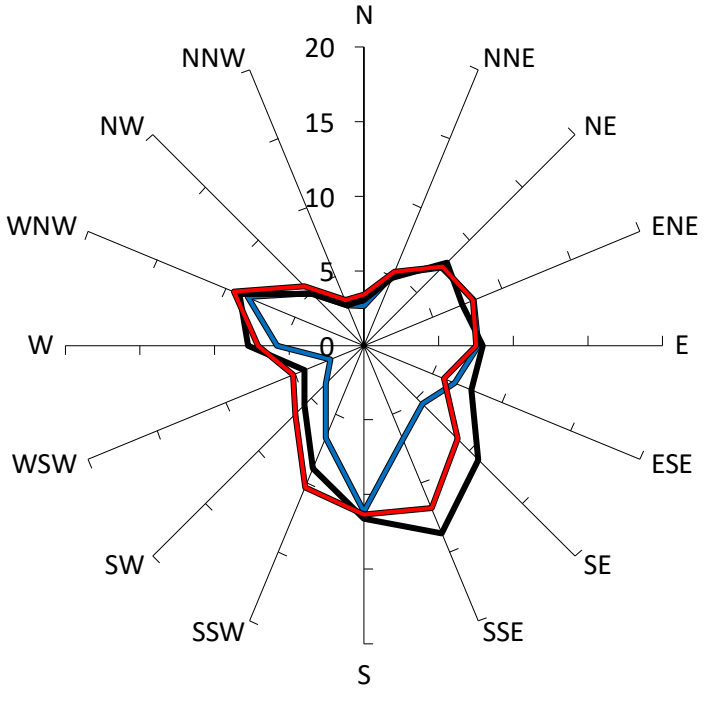


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	20%	24
Existing Case.	32%	30
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	20%	25

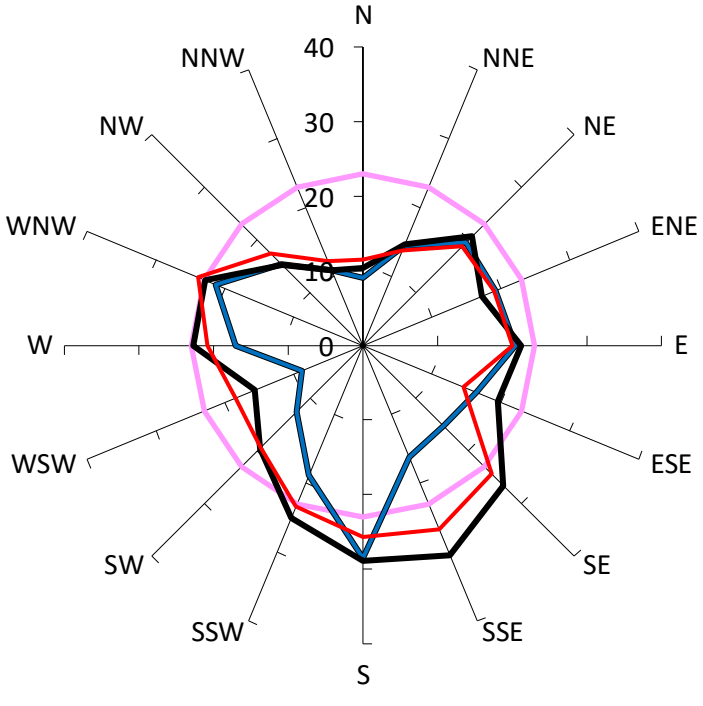
Results for Point 07

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

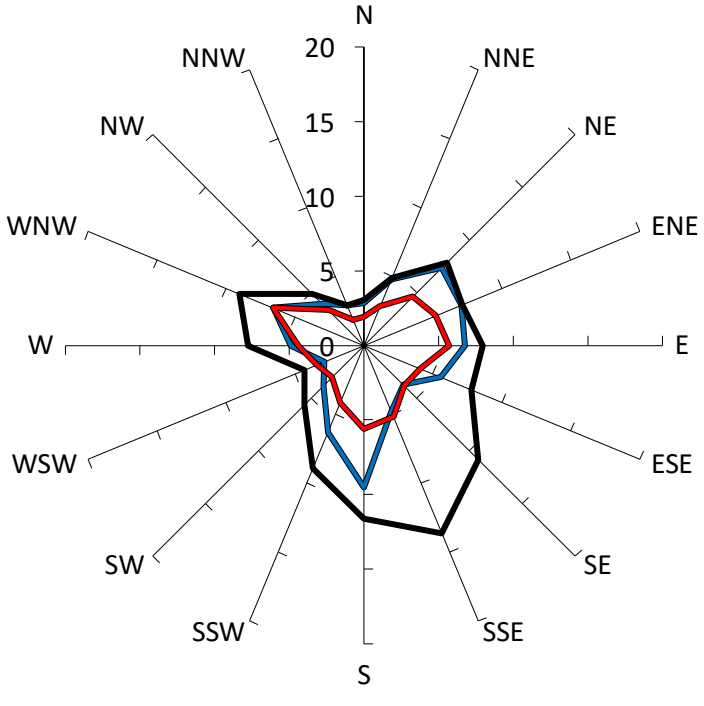


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	9%	29
Existing Case.	18%	30
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	17%	27

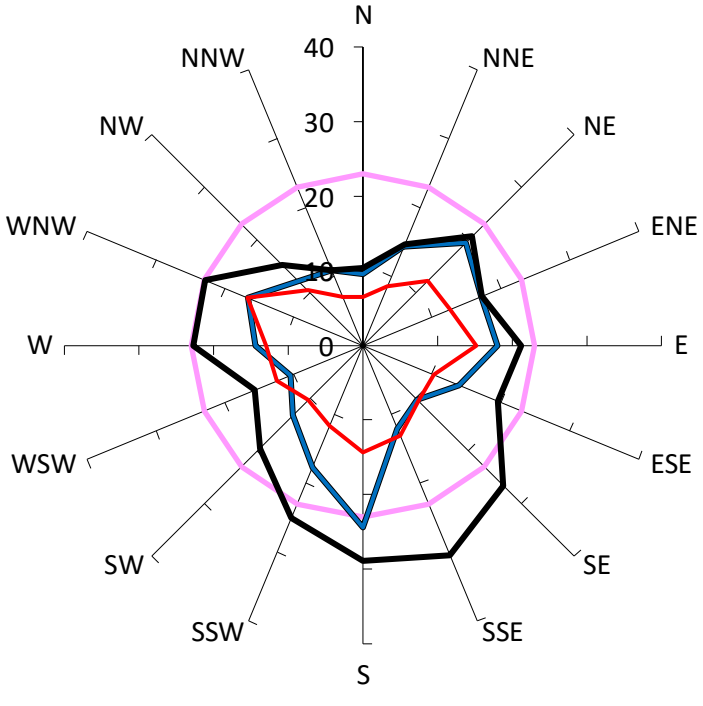
Results for Point 08

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

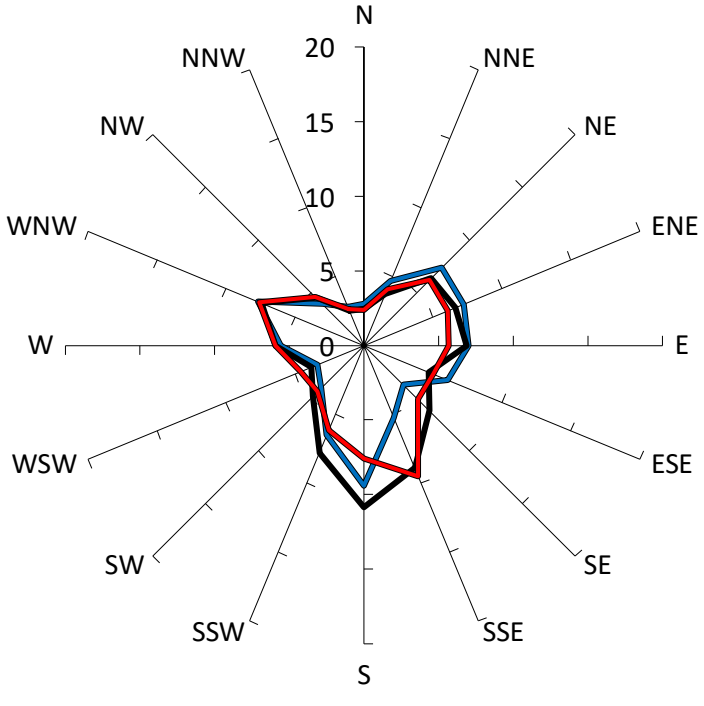


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	16%	24
Existing Case.	32%	30
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	5%	17

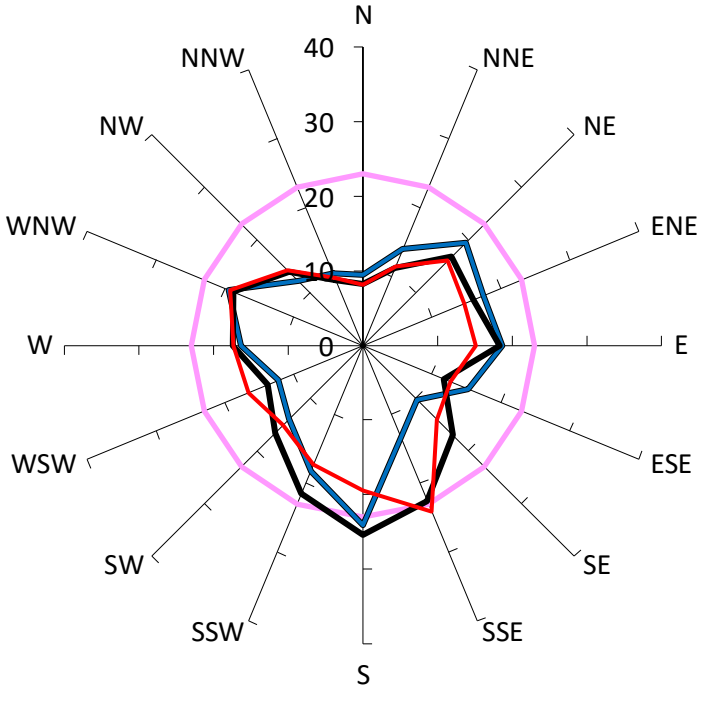
Results for Point 09

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

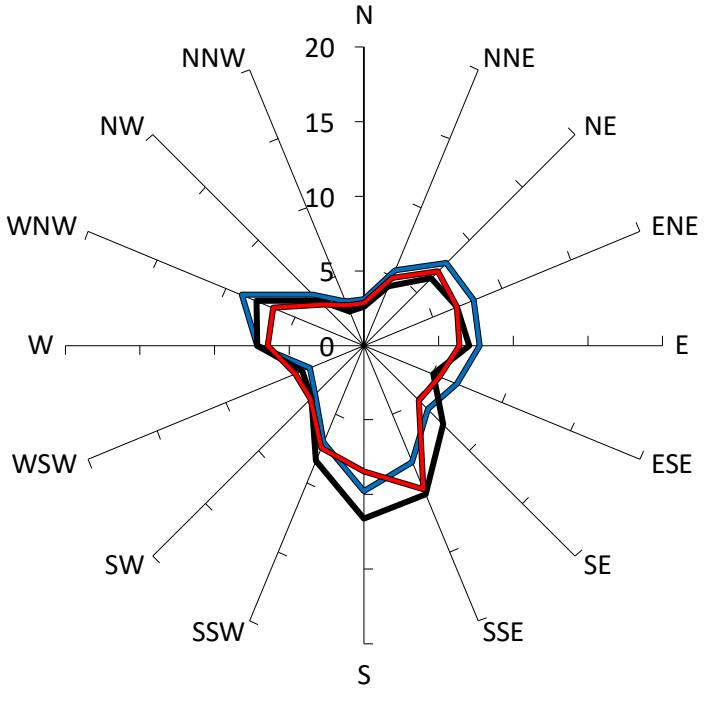


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	6%	24
Existing Case.	9%	25
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	5%	24

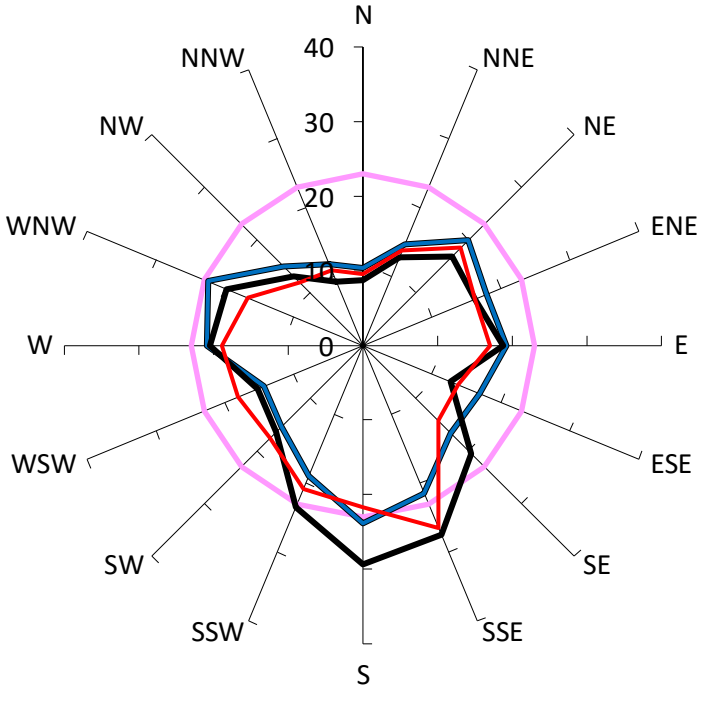
Results for Point 10

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

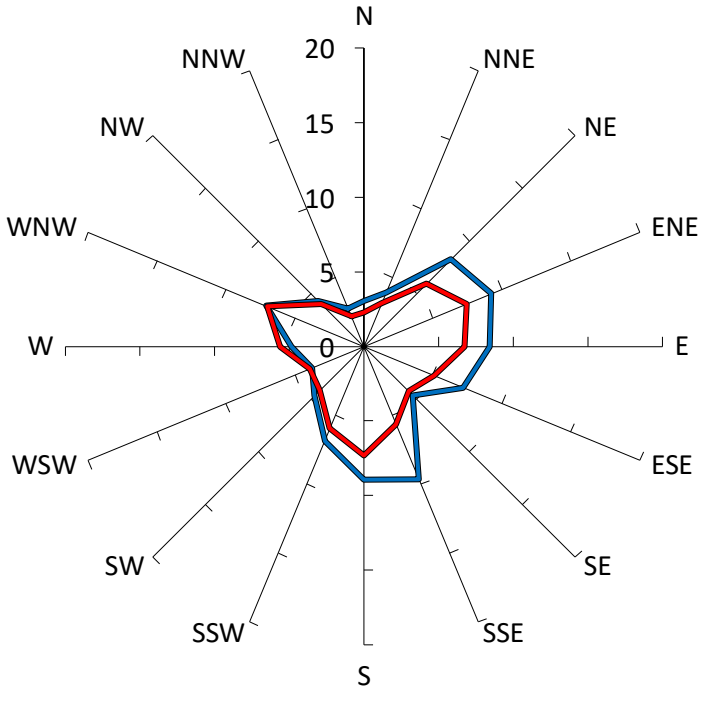


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	11%	24
Existing Case.	12%	29
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	8%	26

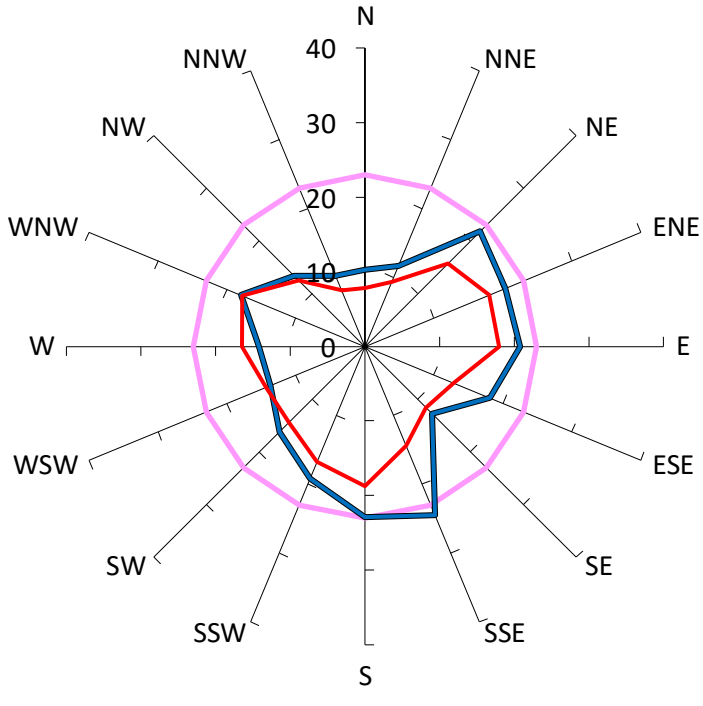
Results for Point 11

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

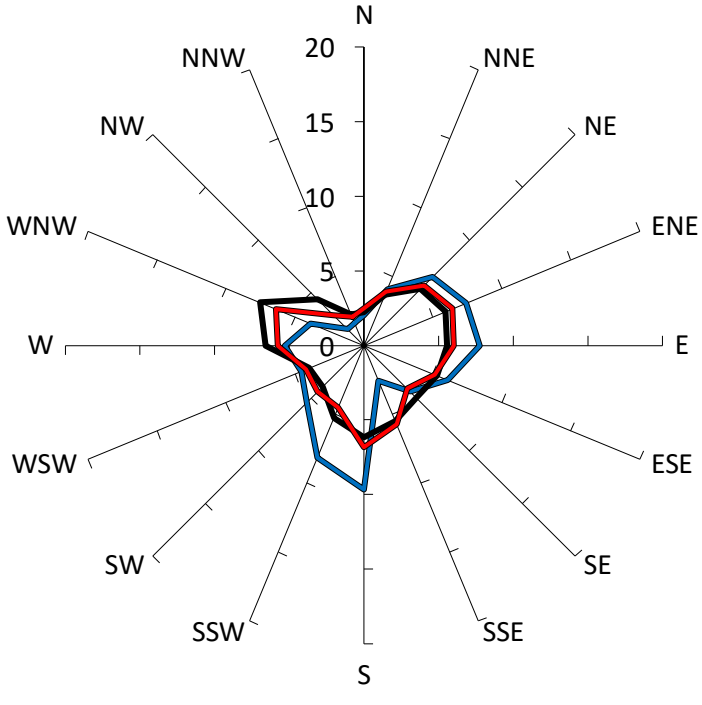


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	11%	24
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	3%	19

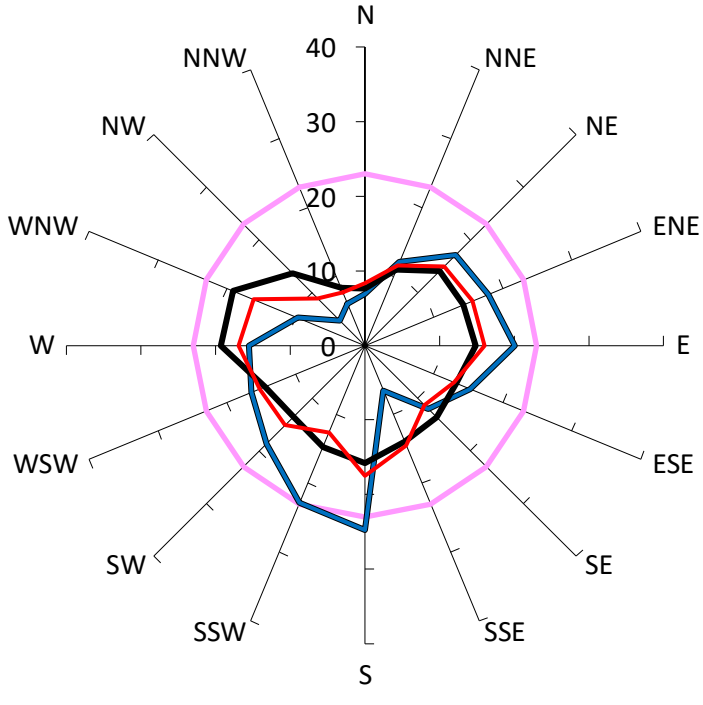
Results for Point 12

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

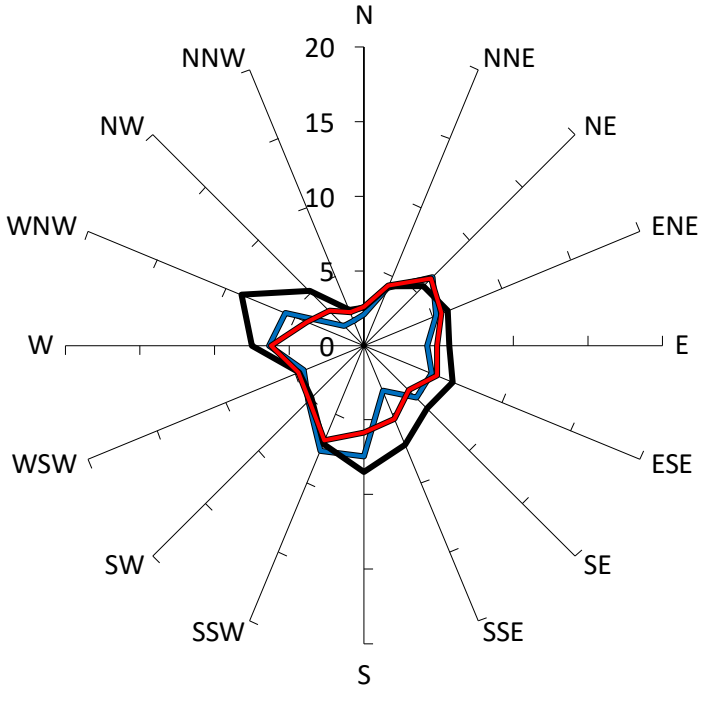


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	16%	25
Existing Case.	11%	19
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	10%	17

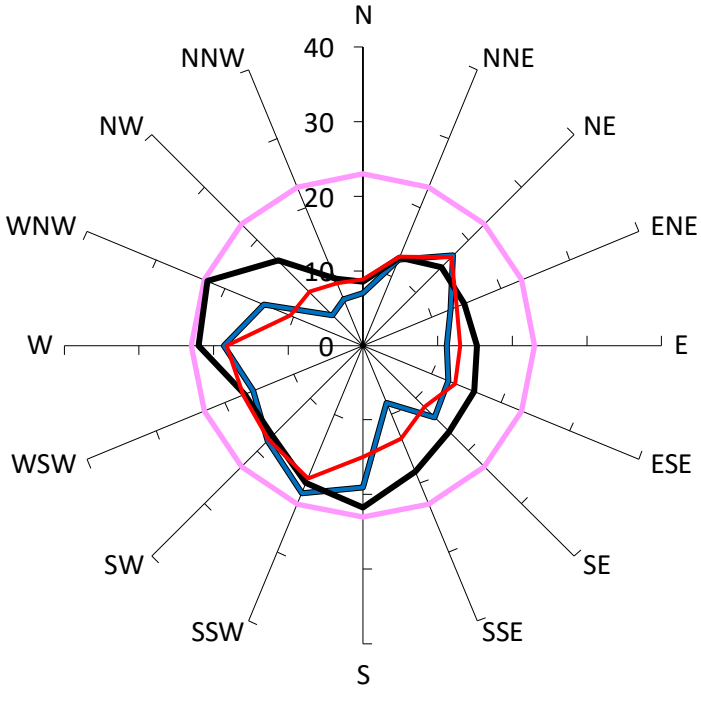
Results for Point 13

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

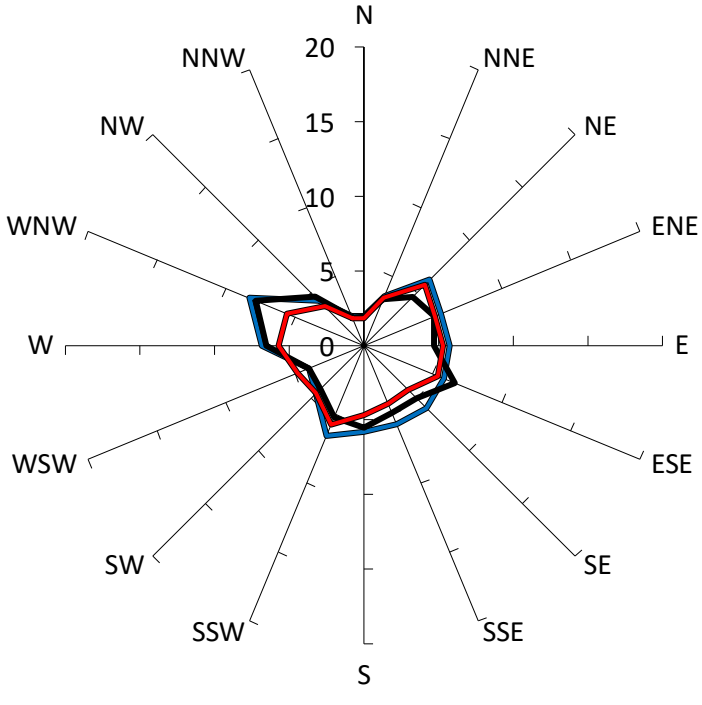


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	3%	21
Existing Case.	6%	23
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	2%	19

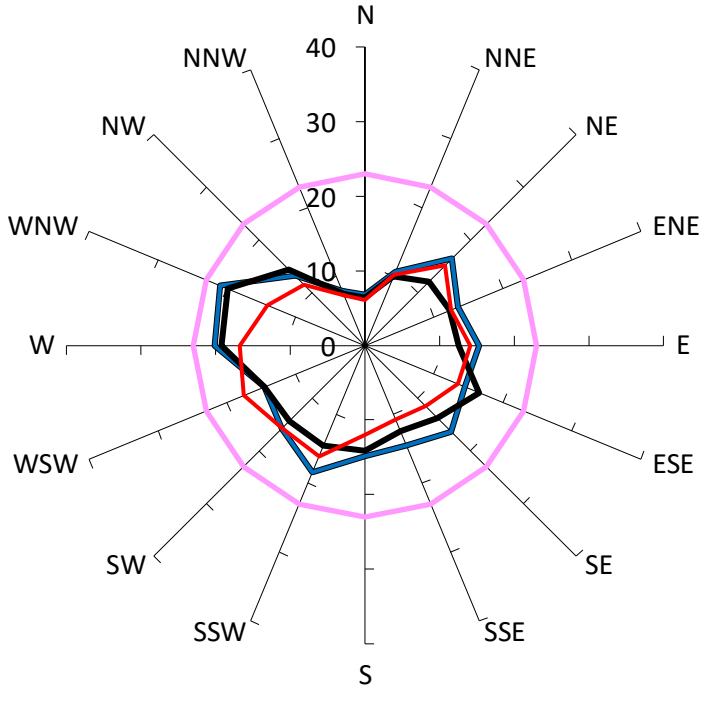
Results for Point 14

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

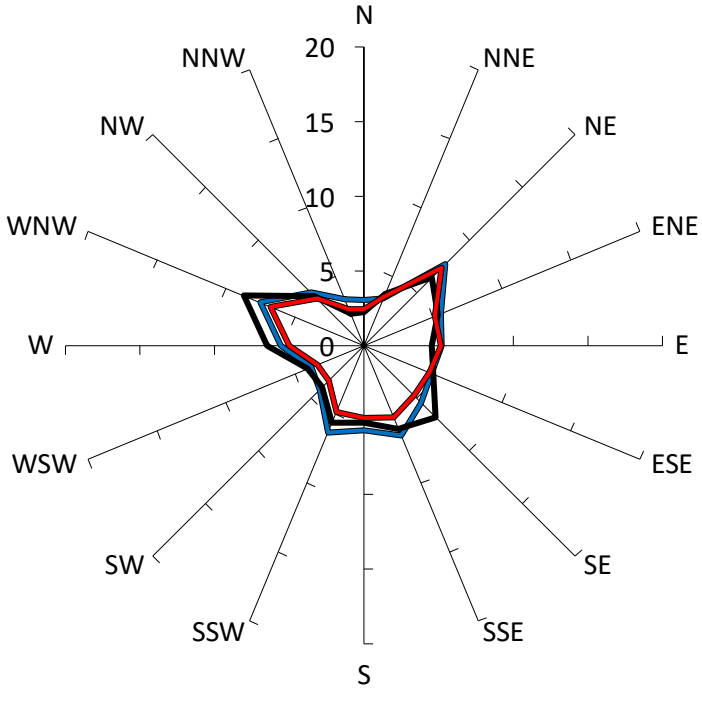


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	15%	21
Existing Case.	10%	20
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	7%	18

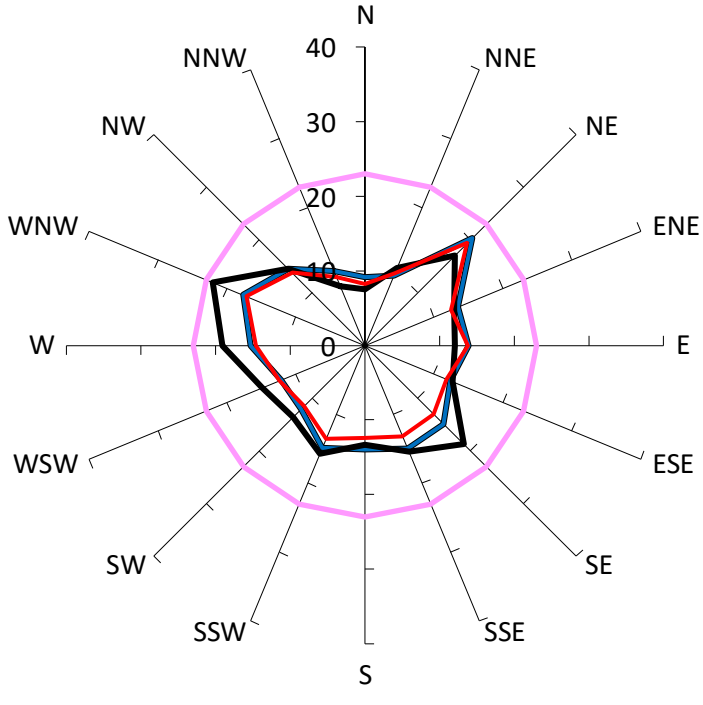
Results for Point 15

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

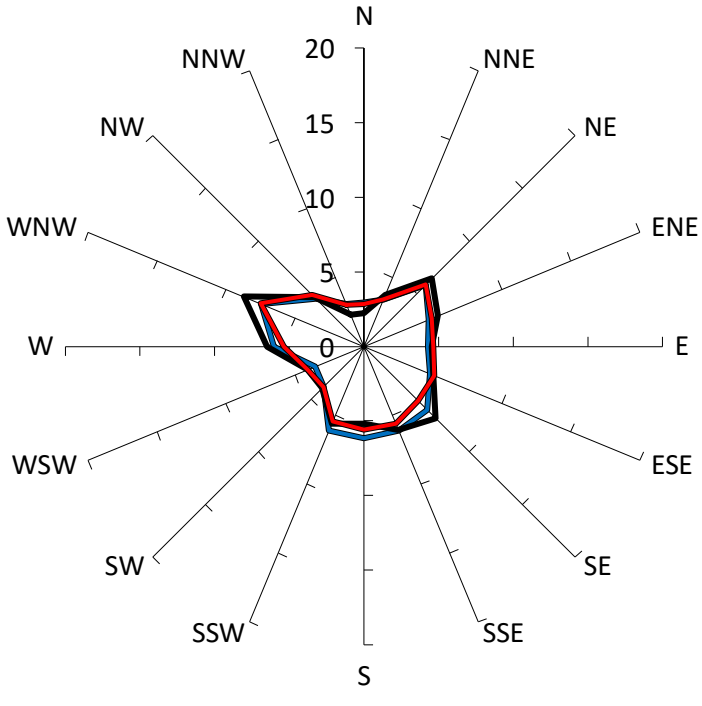


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	14%	20
Existing Case.	15%	22
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	8%	19

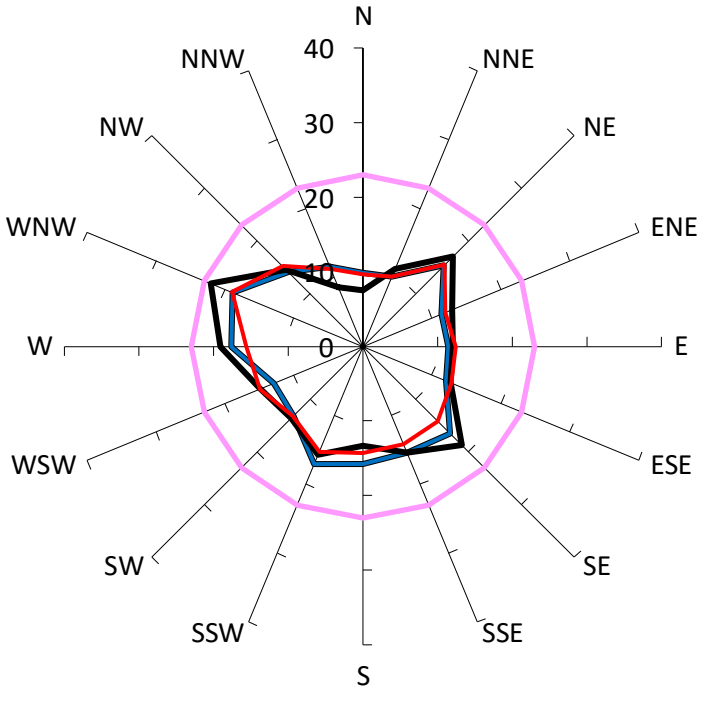
Results for Point 16

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

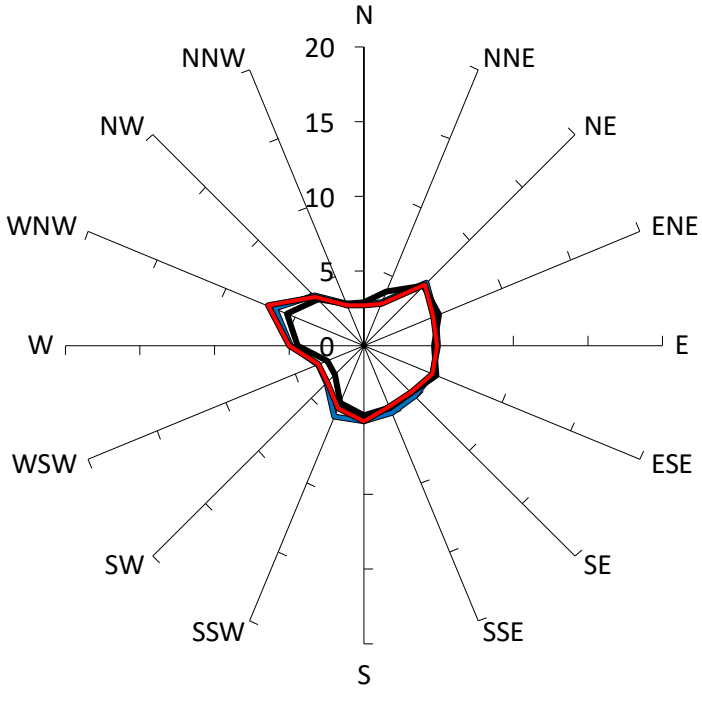


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	2%	19
Existing Case.	3%	22
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	2%	19

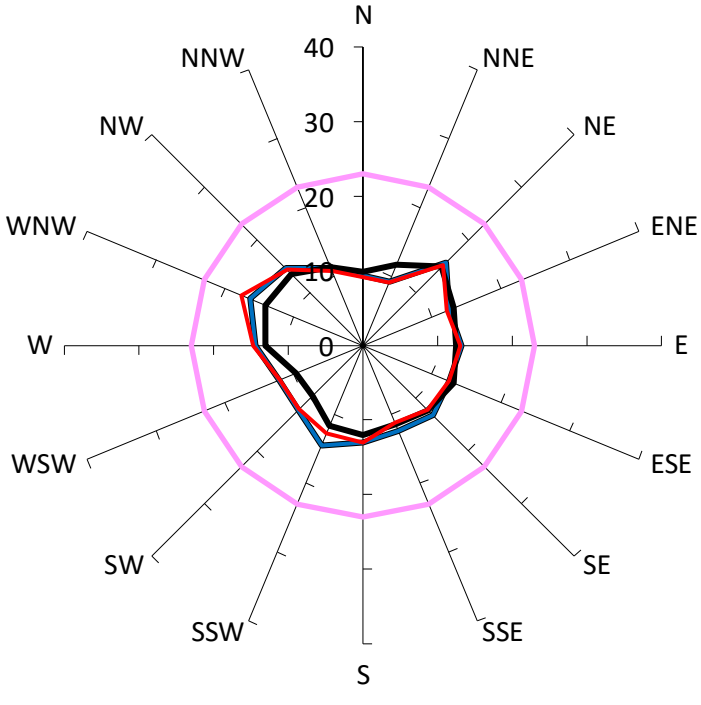
Results for Point 17

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

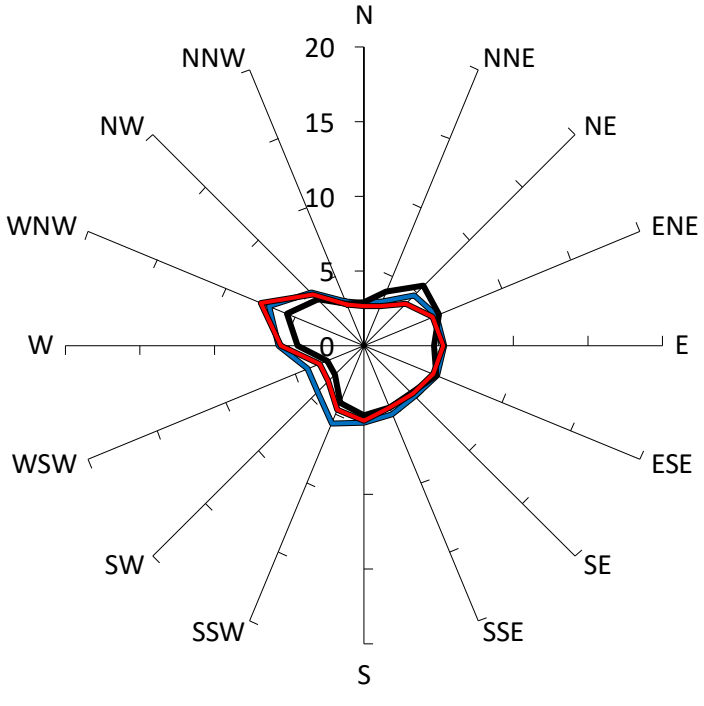


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	1%	16
Existing Case.	< 1%	15
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	1%	18

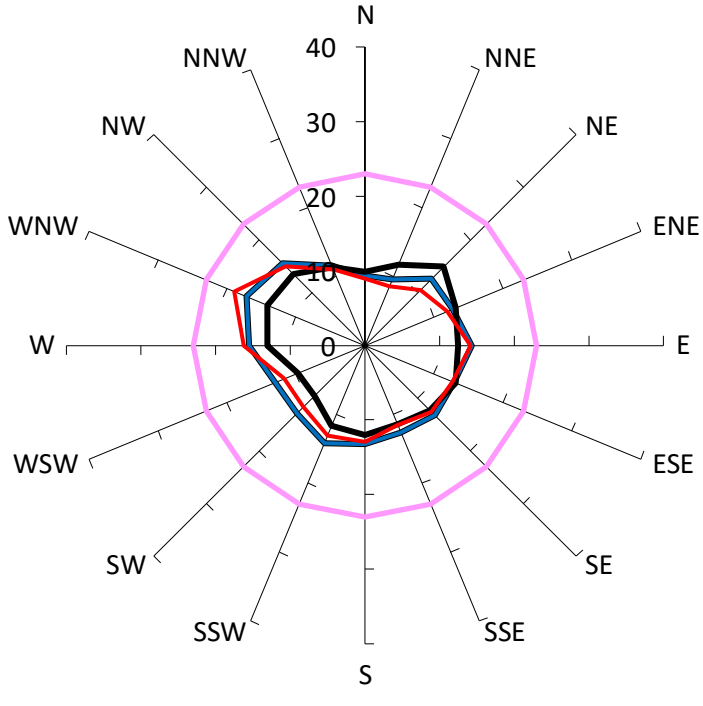
Results for Point 18

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

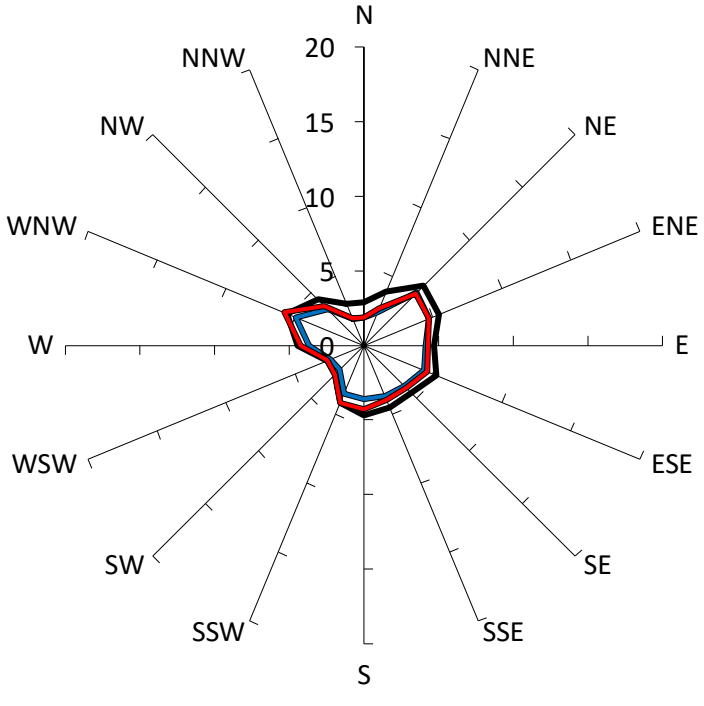


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	8%	17
Existing Case.	4%	15
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	7%	19

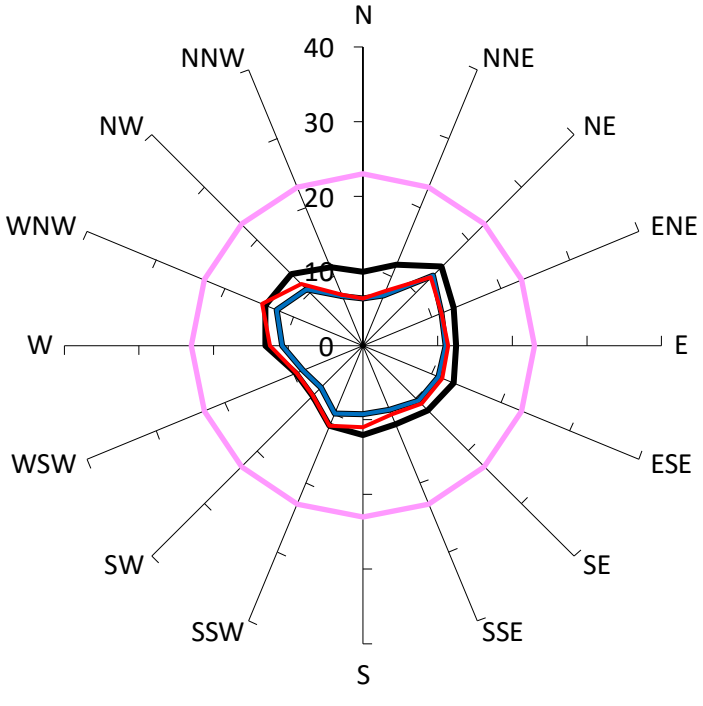
Results for Point 19

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

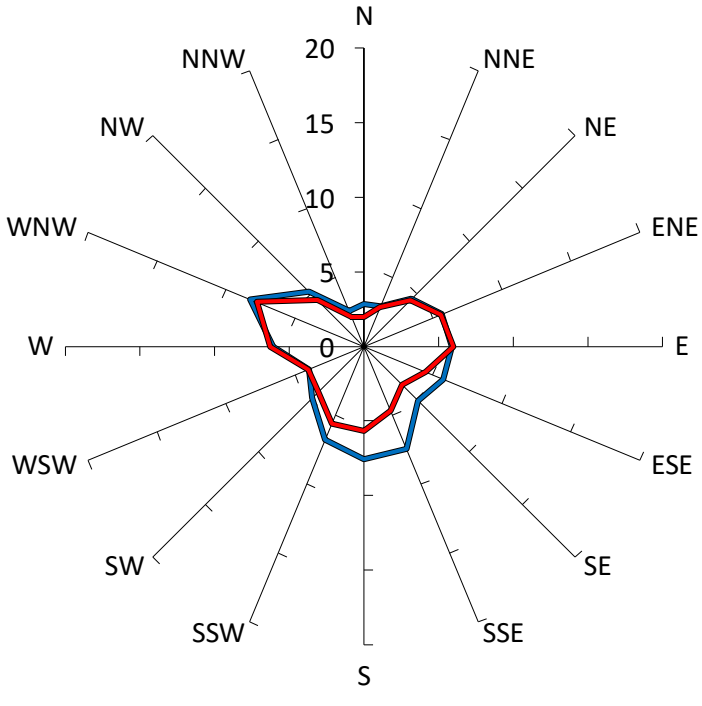


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	< 1%	13
Existing Case.	< 1%	15
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	< 1%	15

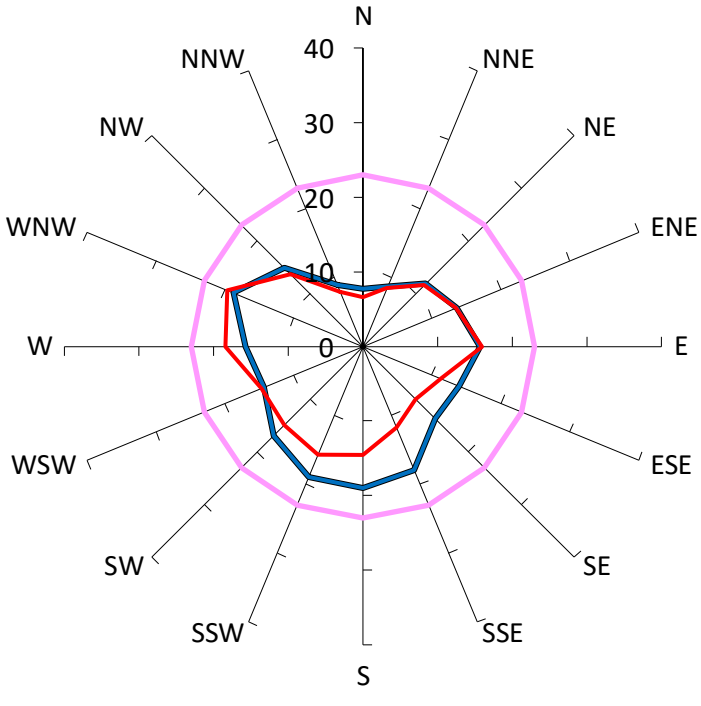
Results for Point 20

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

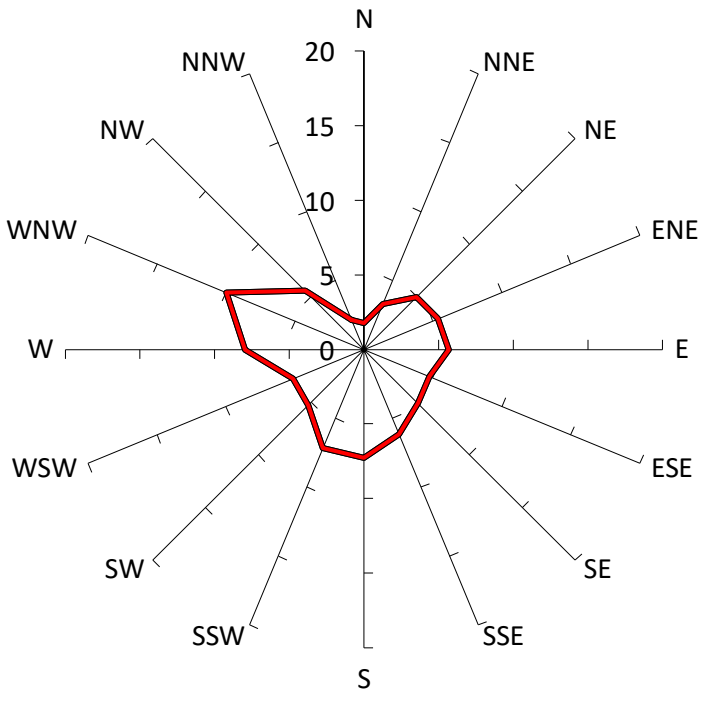


Safety Limit: 23m/s

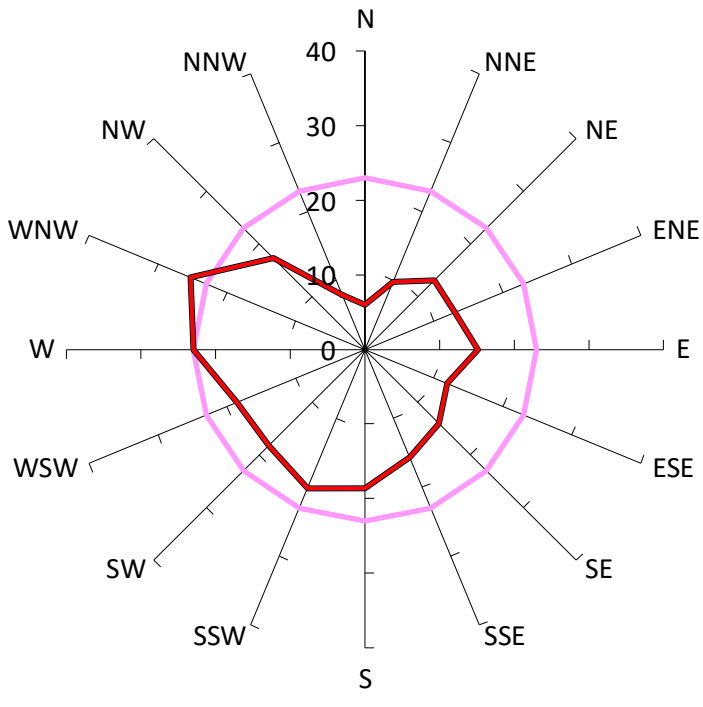
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	4%	19
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	2%	20

Results for Point 21

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

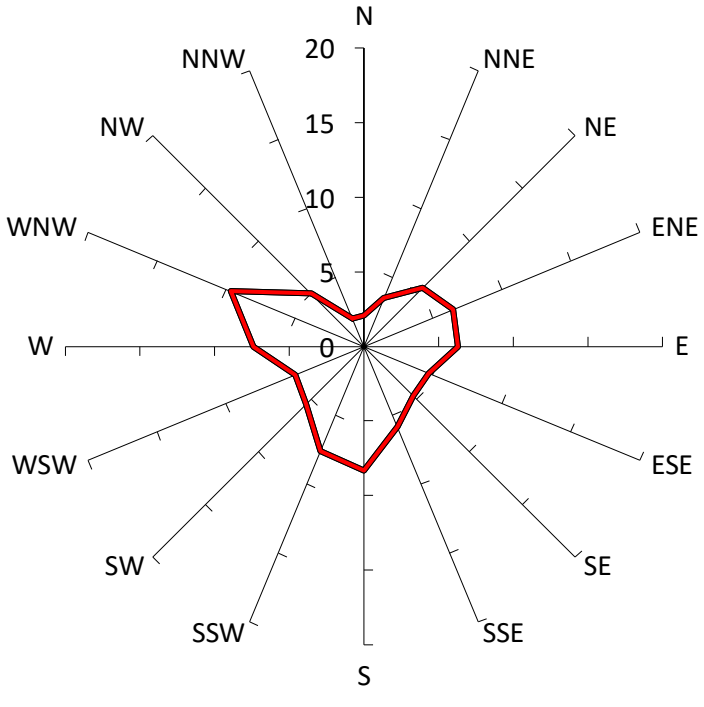


Safety Limit: 23m/s

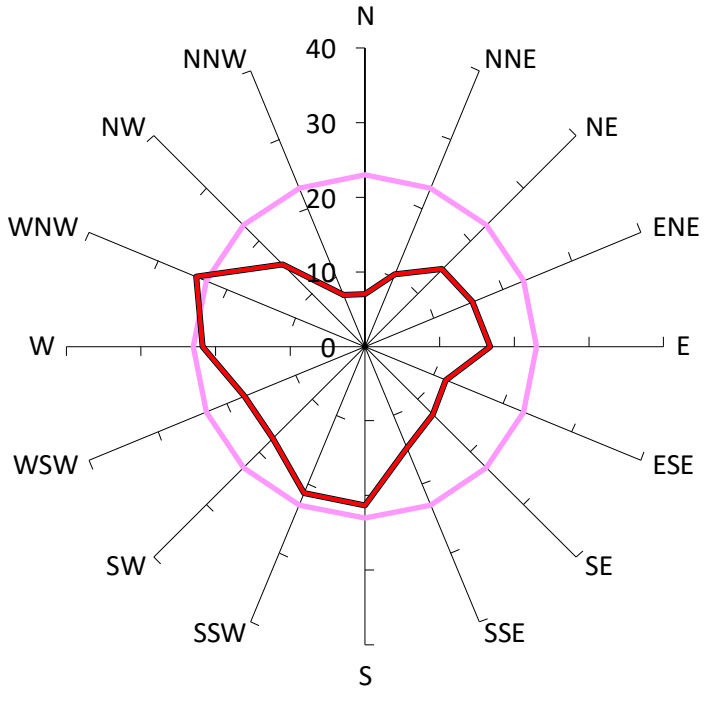
	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 1 and Stage 2 Cases.	7%	25
	With development "as proposed", no vegetation or other treatments. Stage 1 and Stage 2 Cases.	7%	25

Results for Point 22

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

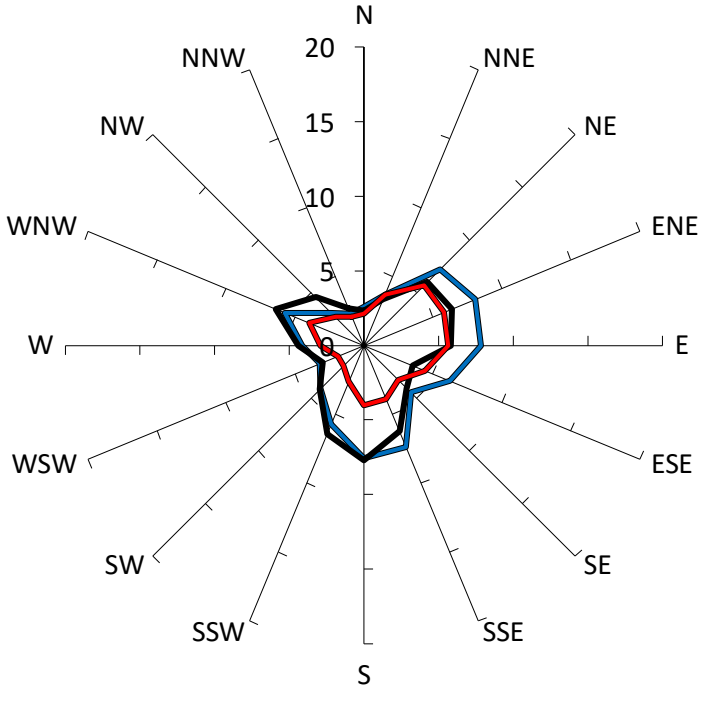


Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 1 and Stage 2 Cases.	7%	24
	With development "as proposed", no vegetation or other treatments. Stage 1 and Stage 2 Cases.	7%	24

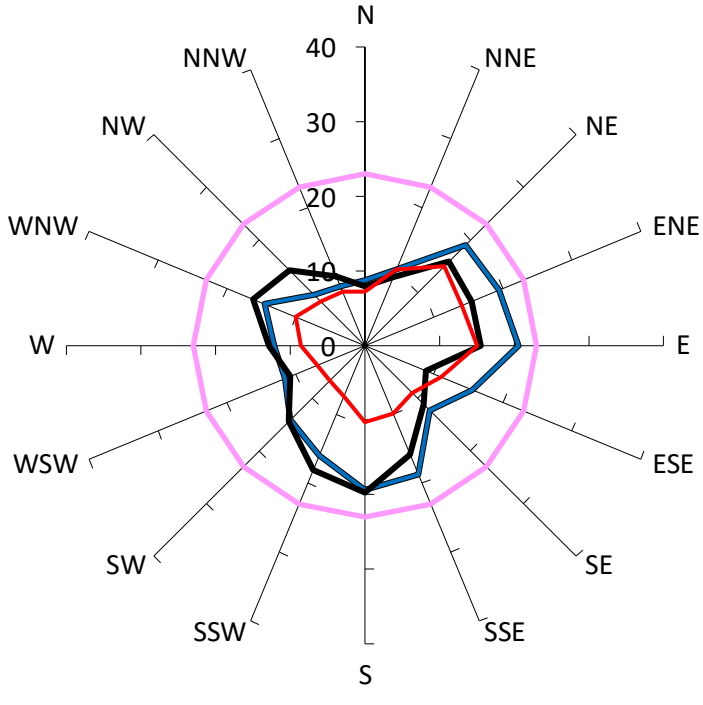
Results for Point 23

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

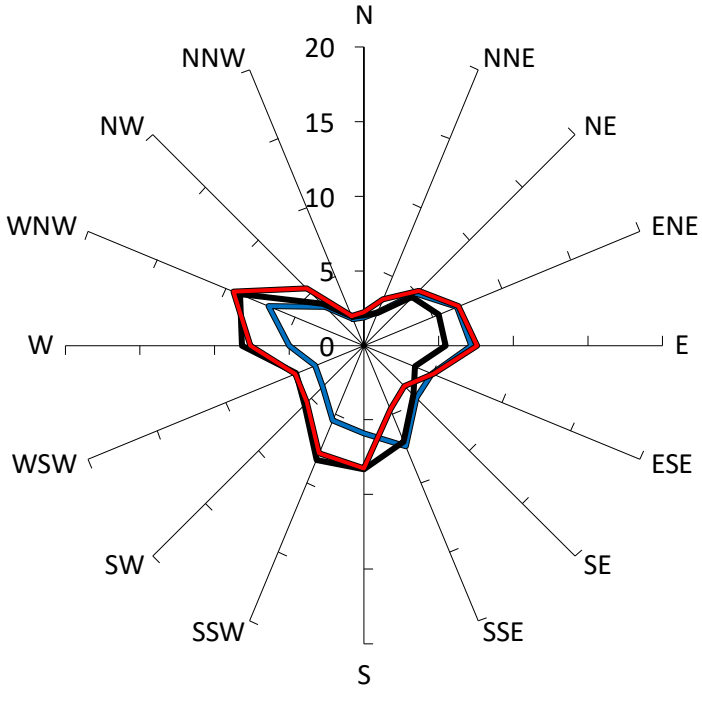


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	17%	21
Existing Case.	12%	20
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	3%	15

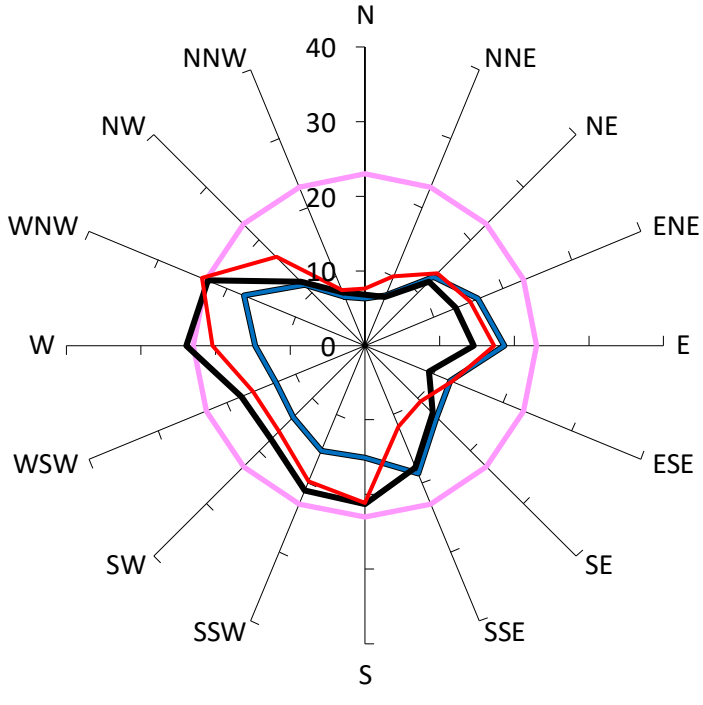
Results for Point 24

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

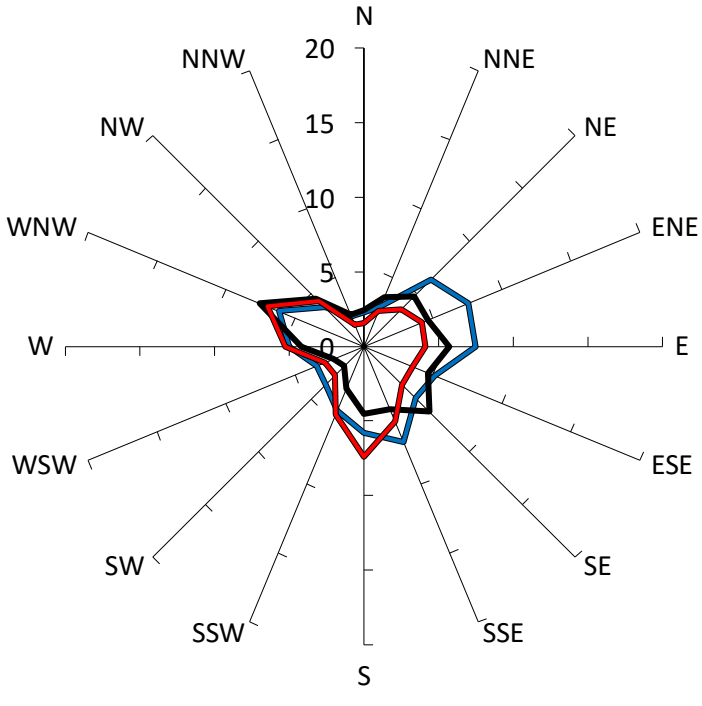


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	13%	19
Existing Case.	20%	24
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	23%	24

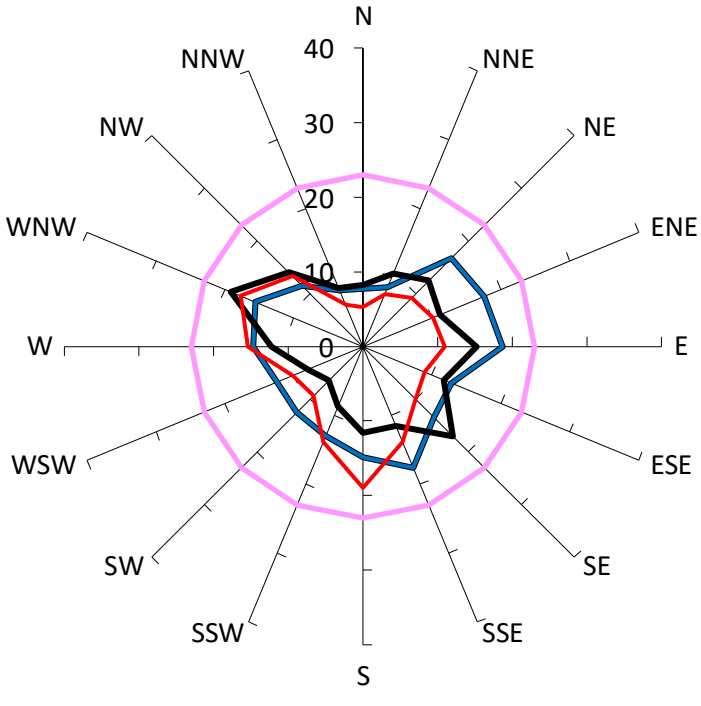
Results for Point 25

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

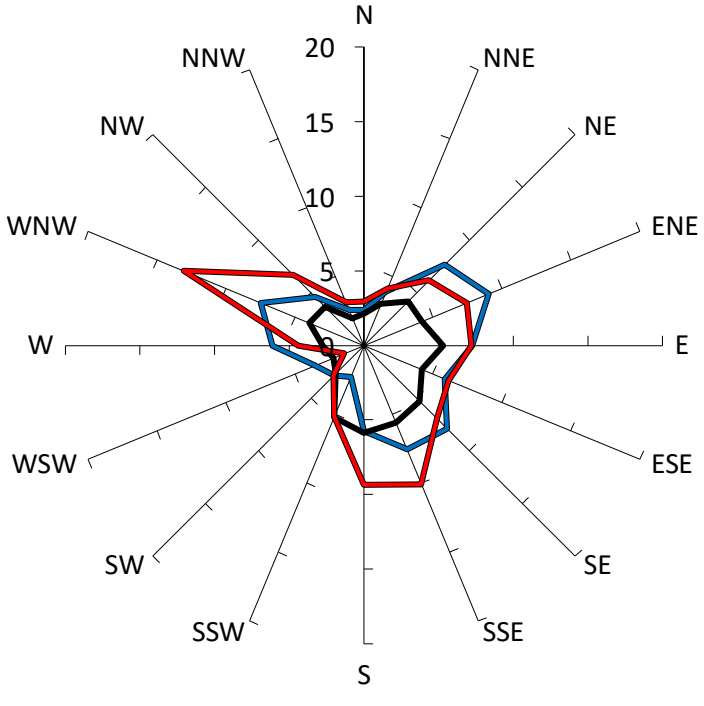


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	3%	19
Existing Case.	1%	19
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	1%	19

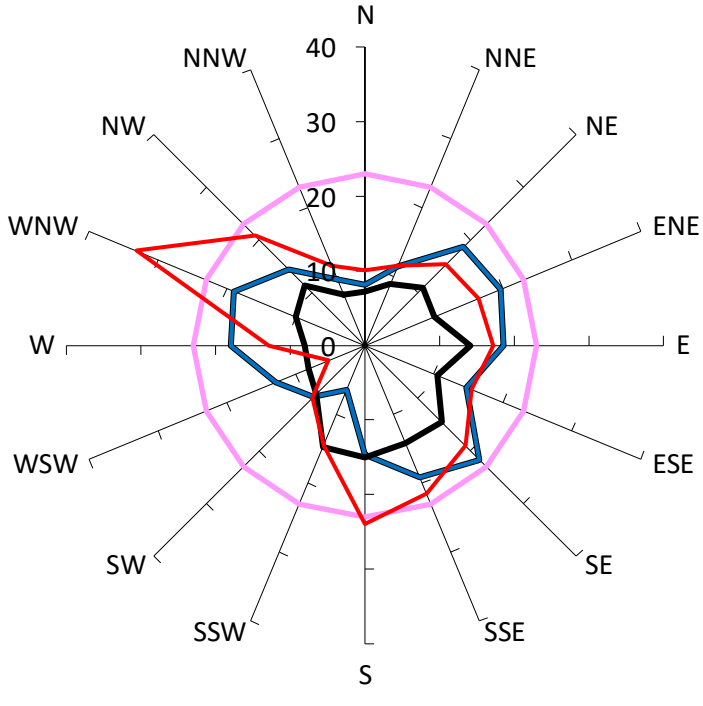
Results for Point 26

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

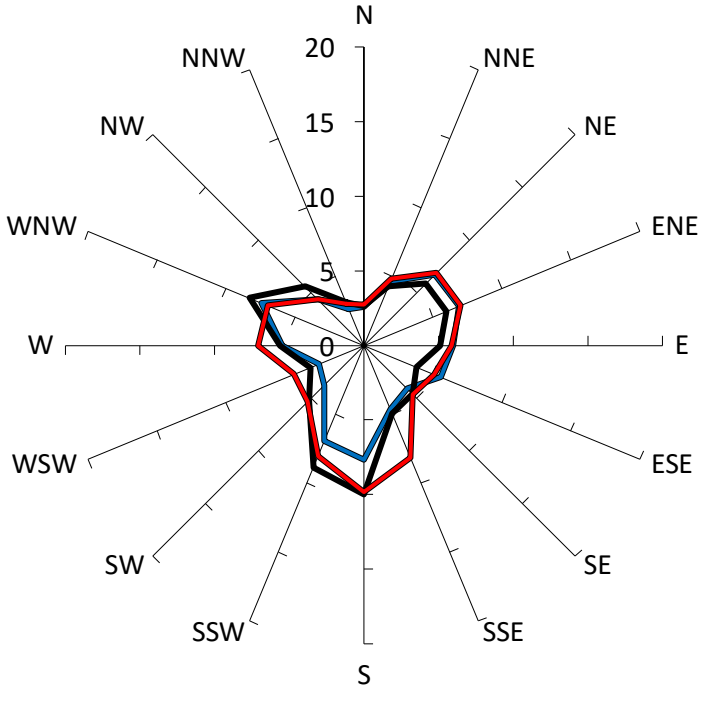


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	20%	22
Existing Case.	4%	15
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	26%	33

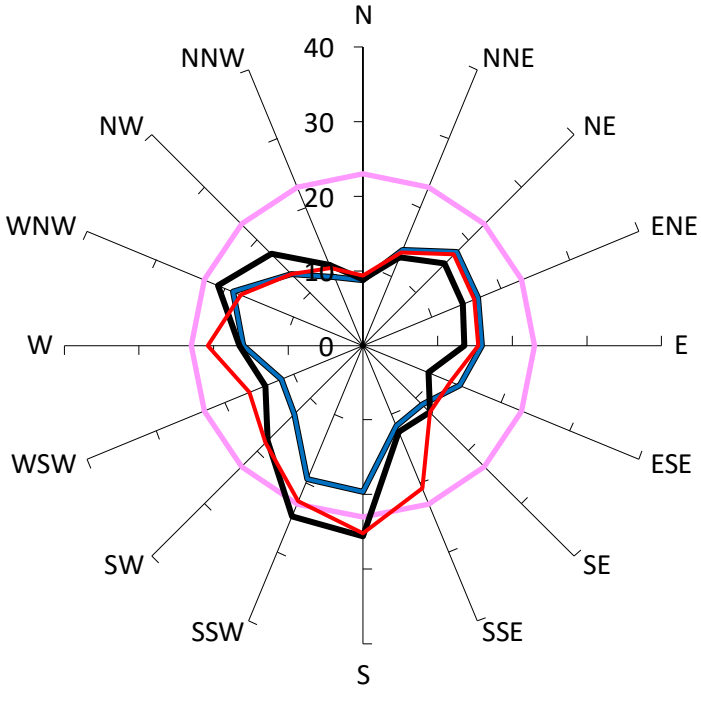
Results for Point 27

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

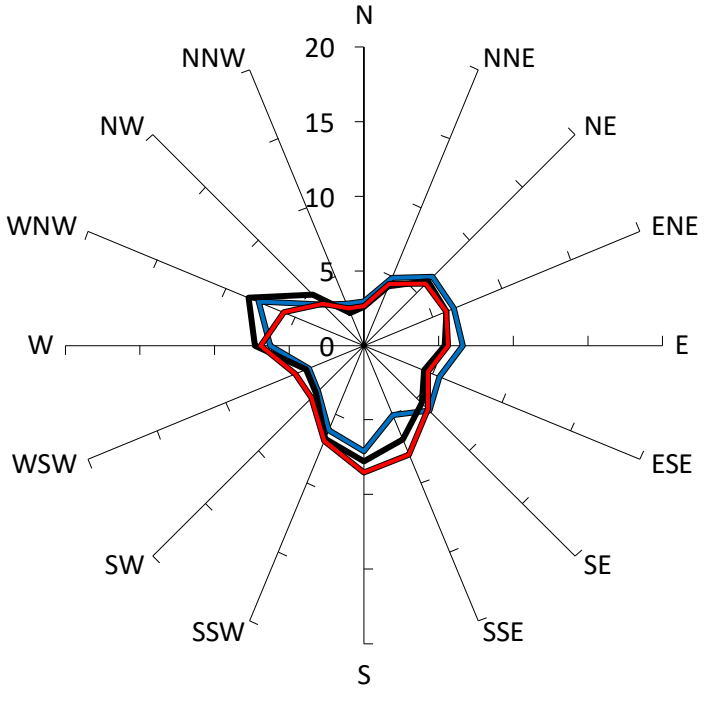


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	3%	20
Existing Case.	7%	26
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	8%	25

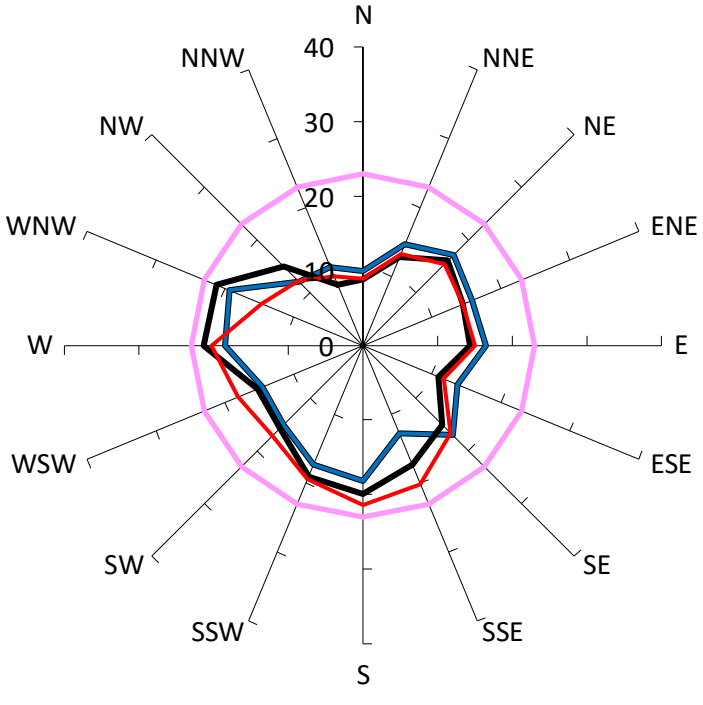
Results for Point 28

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

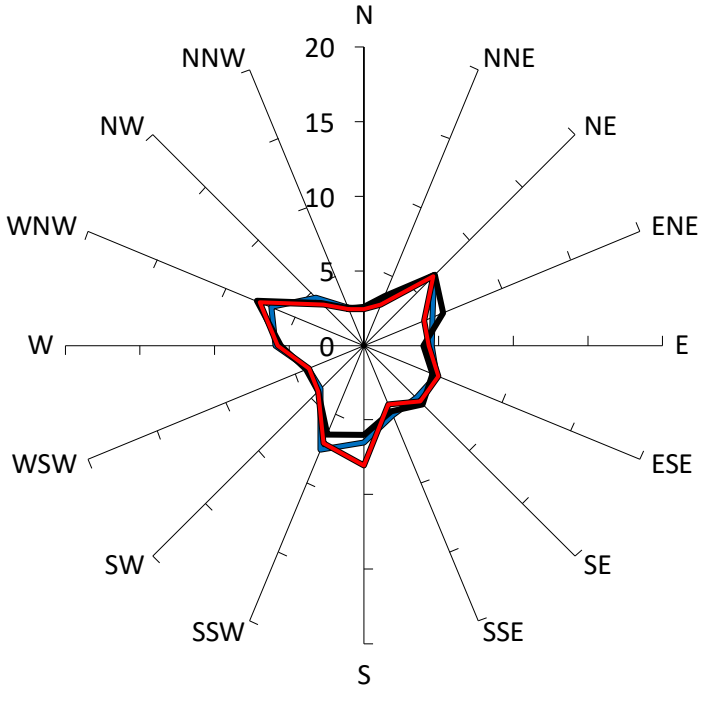


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	3%	19
Existing Case.	5%	21
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	5%	21

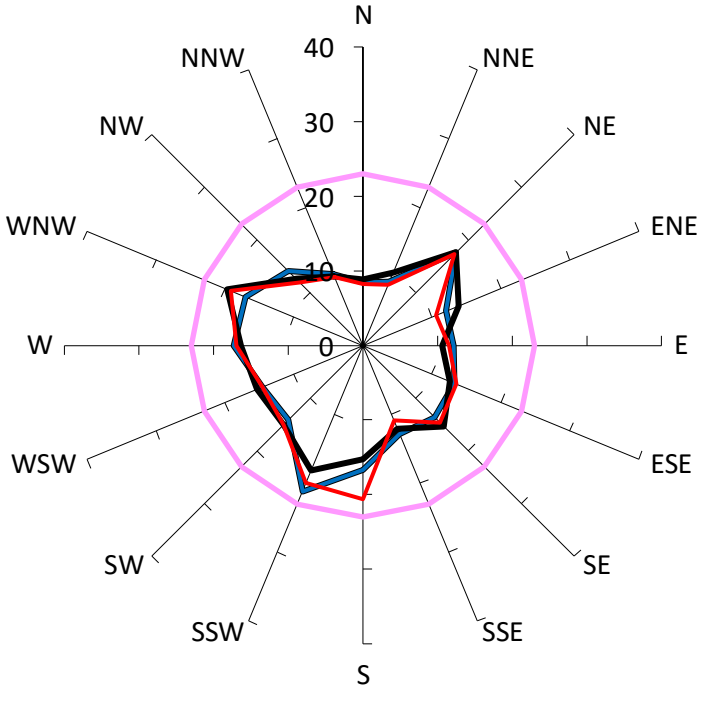
Results for Point 29

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

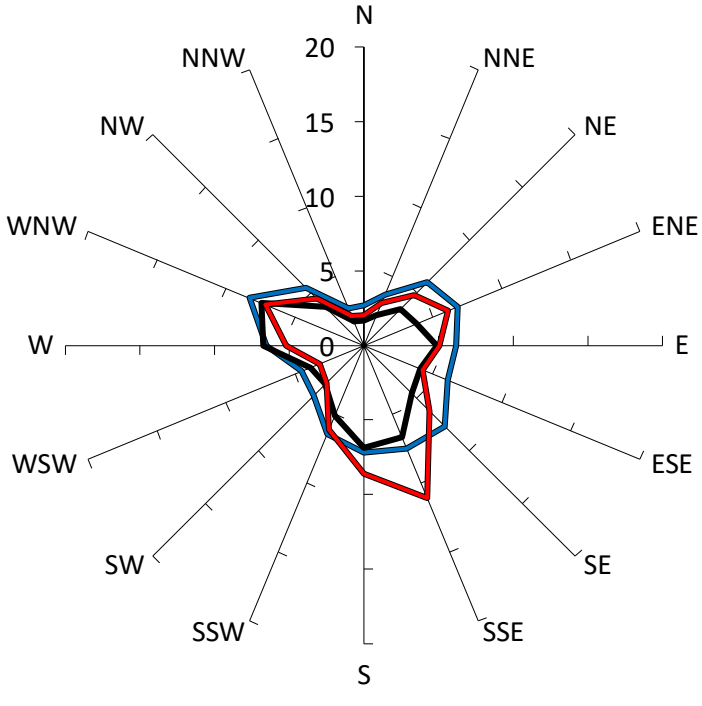


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	2%	21
Existing Case.	2%	20
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	3%	21

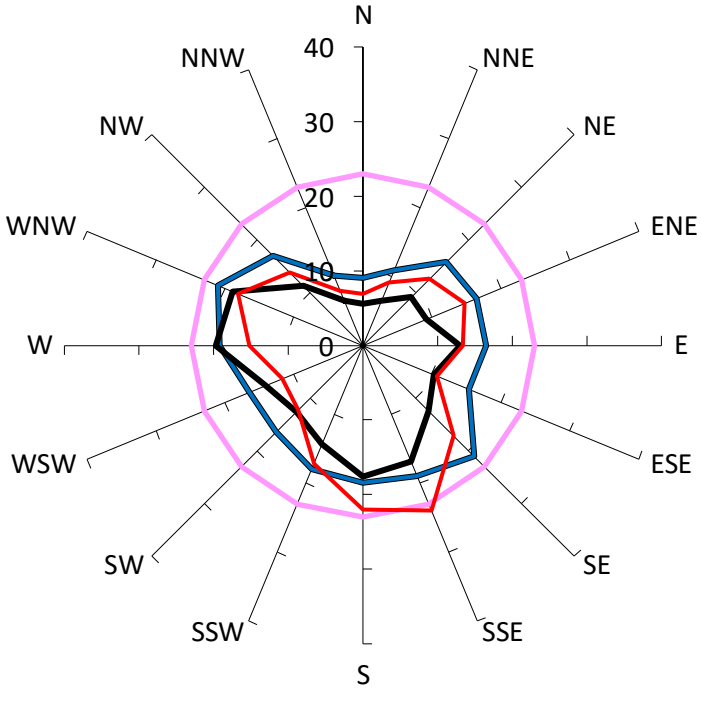
Results for Point 30

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

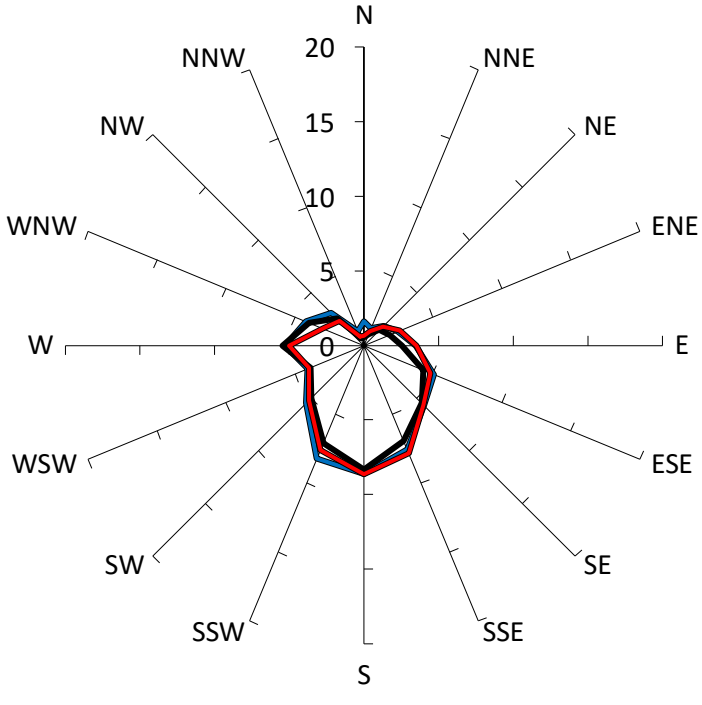


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	5%	21
Existing Case.	2%	20
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	6%	24

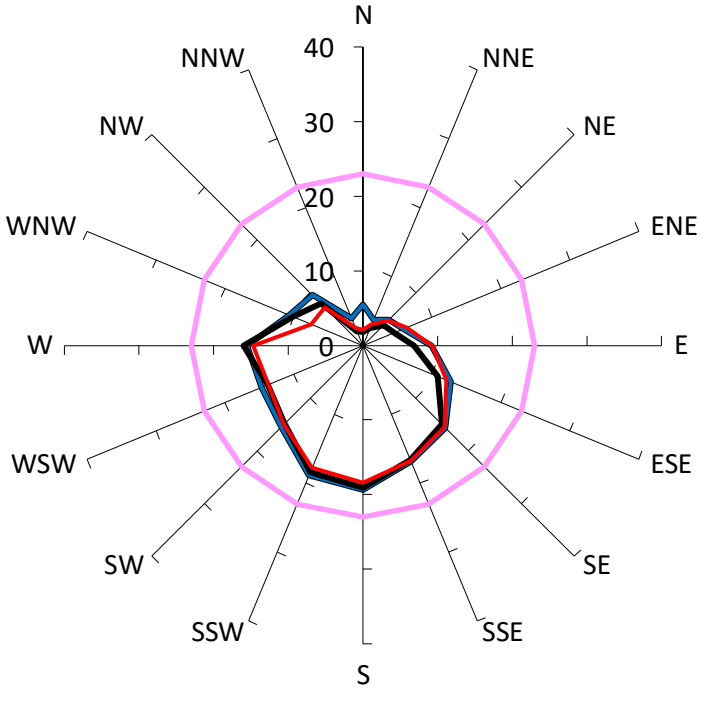
Results for Point 30a

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

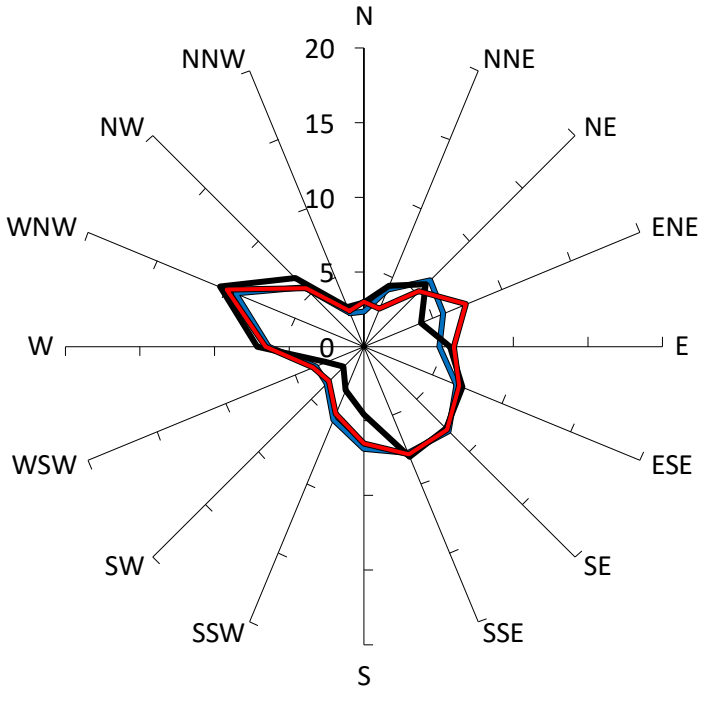


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	4%	19
Existing Case.	3%	19
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	4%	18

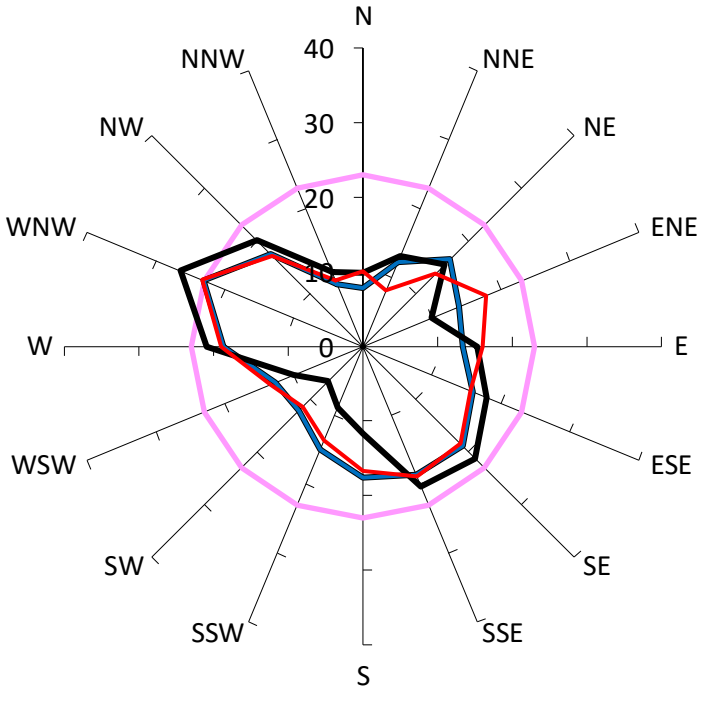
Results for Point 30b

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

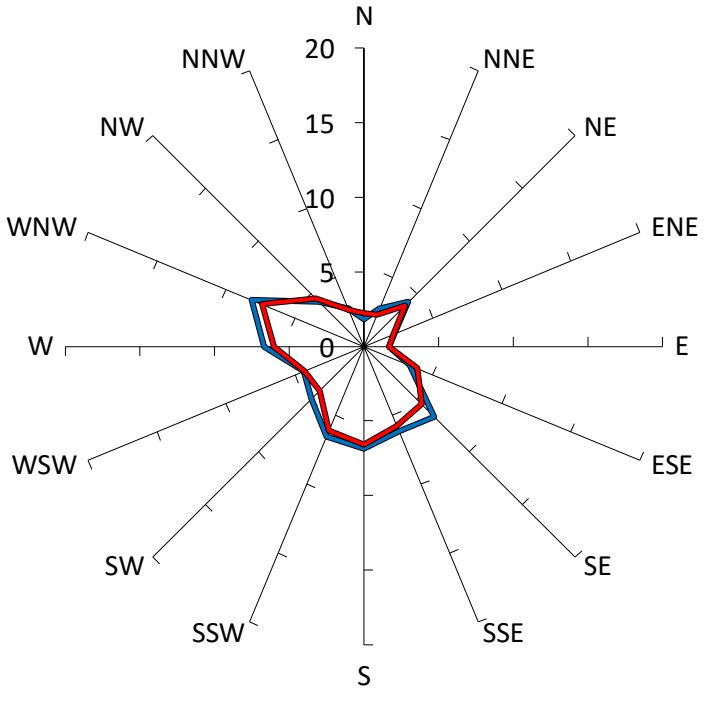


Safety Limit: 23m/s

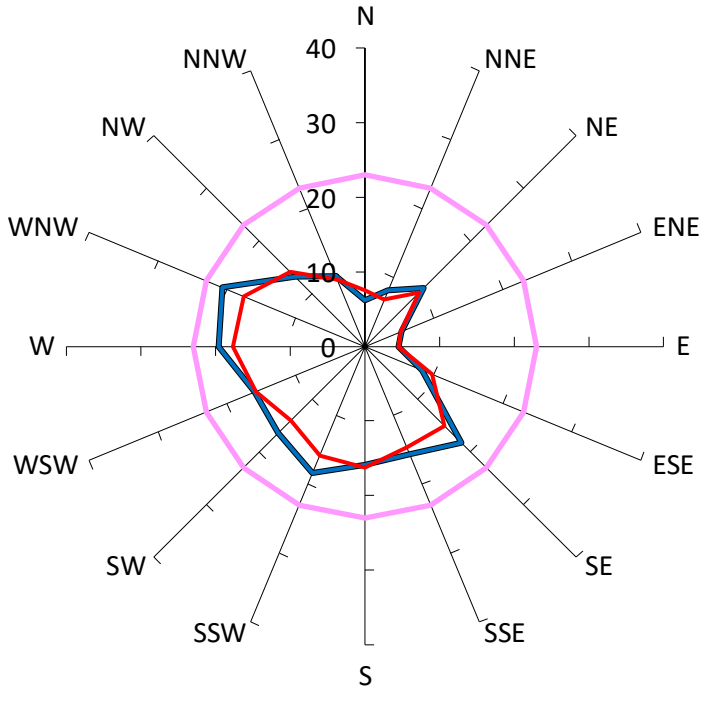
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	6%	23
Existing Case.	7%	26
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	7%	23

Results for Point 31

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

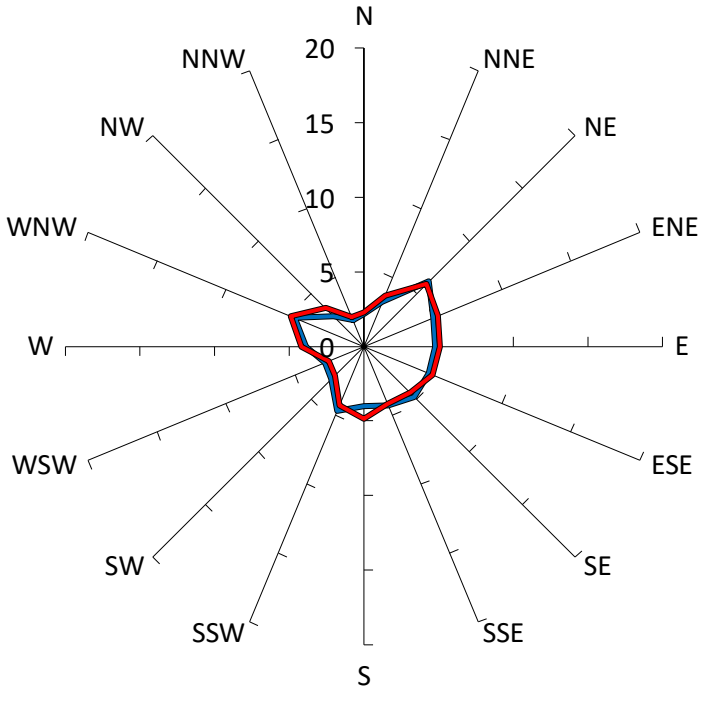


Safety Limit: 23m/s

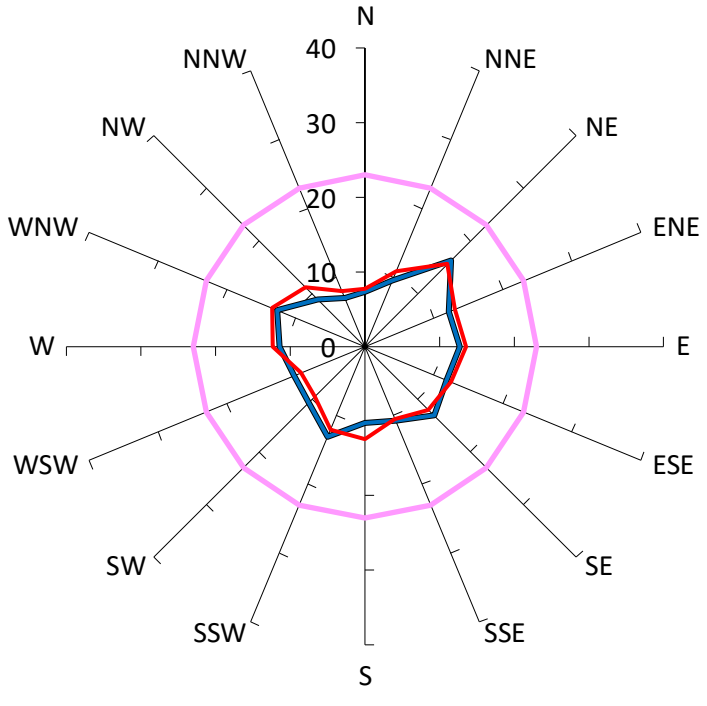
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	14%	21
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	10%	18

Results for Point 32

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

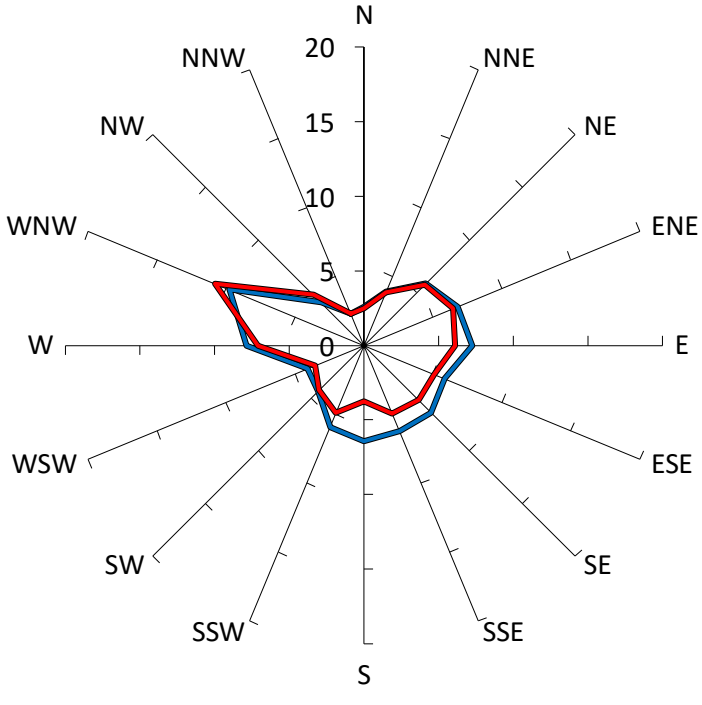


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	3%	16
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	4%	16

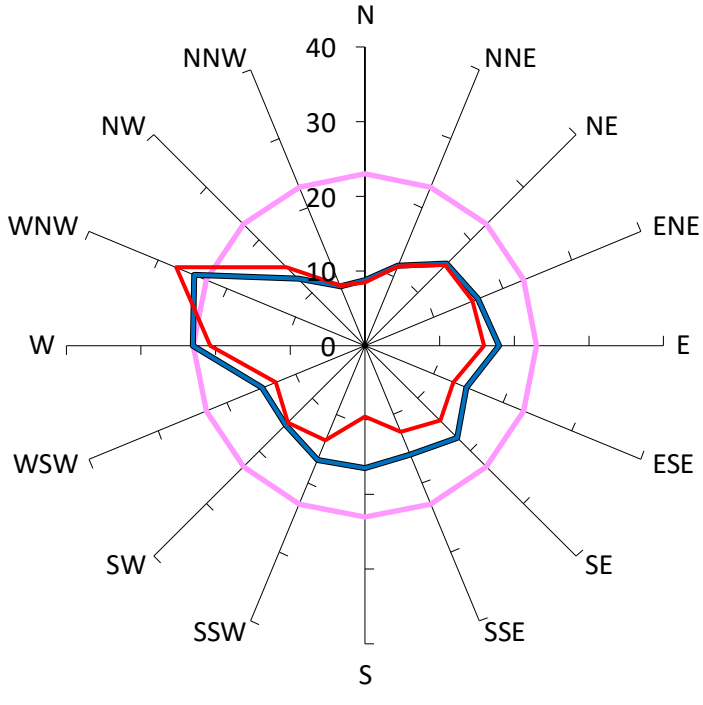
Results for Point 34

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

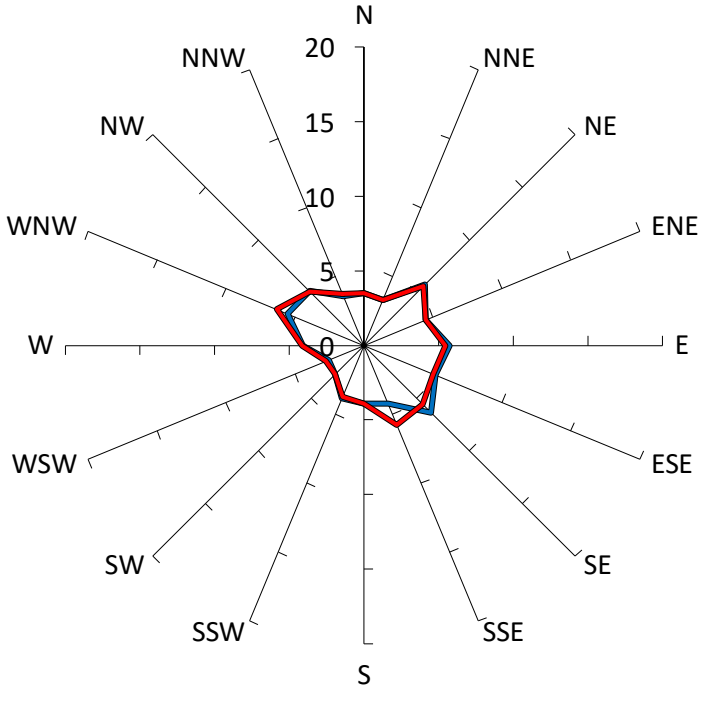


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	21%	25
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	17%	27

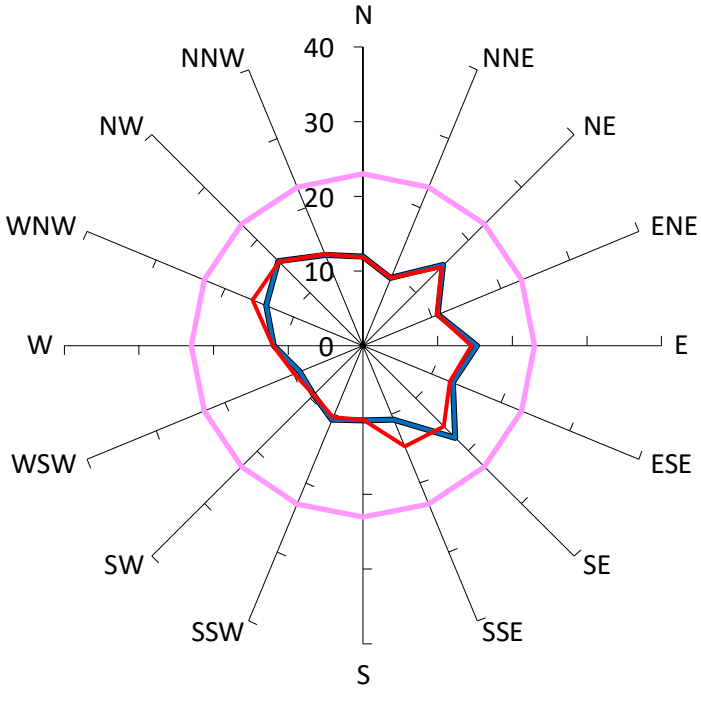
Results for Point 36

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

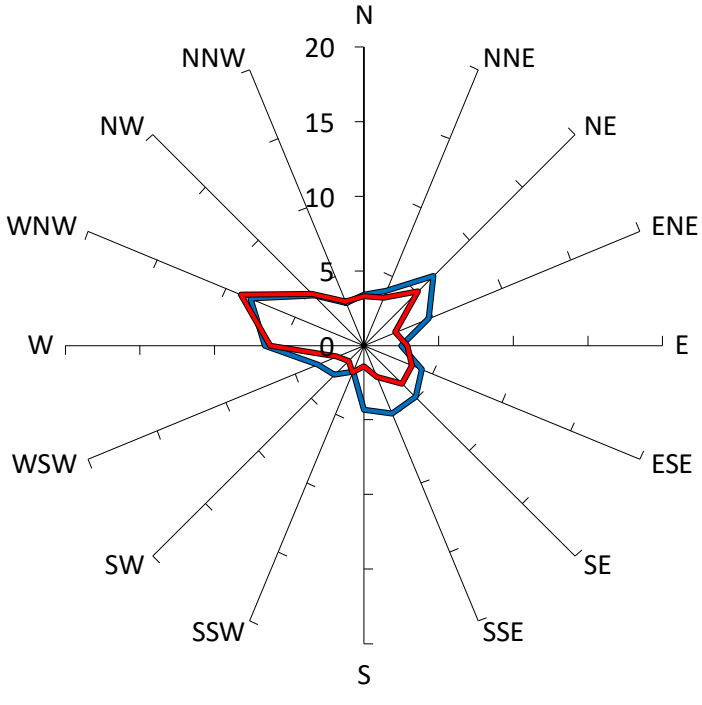


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	1%	18
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	1%	16

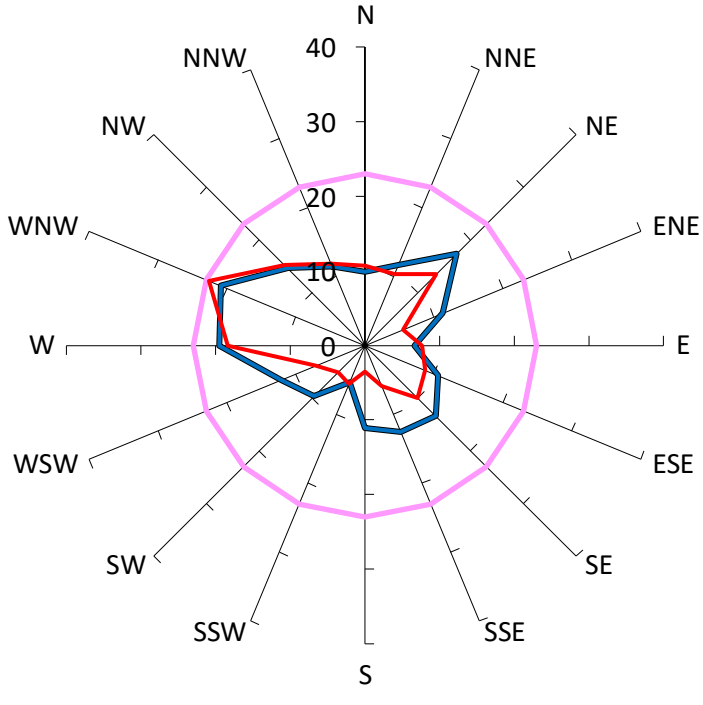
Results for Point 37

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

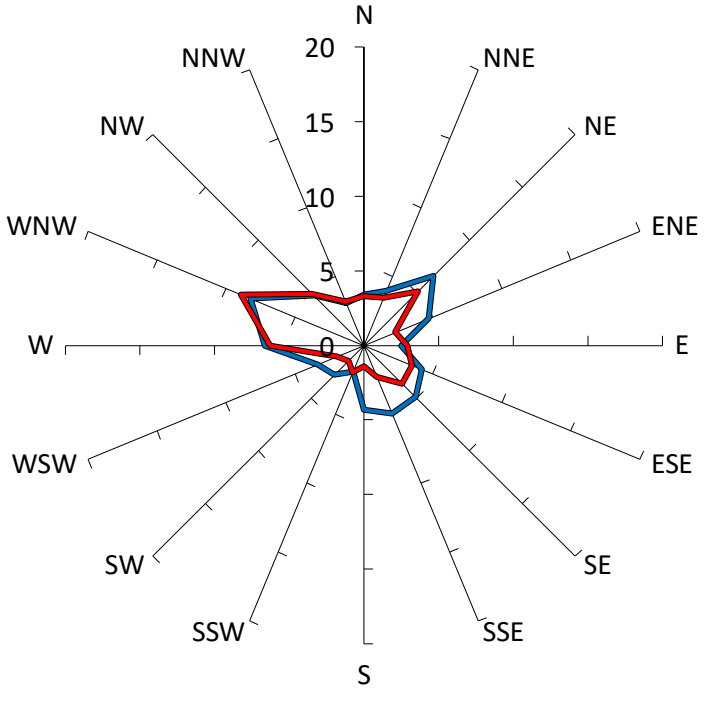


Safety Limit: 23m/s

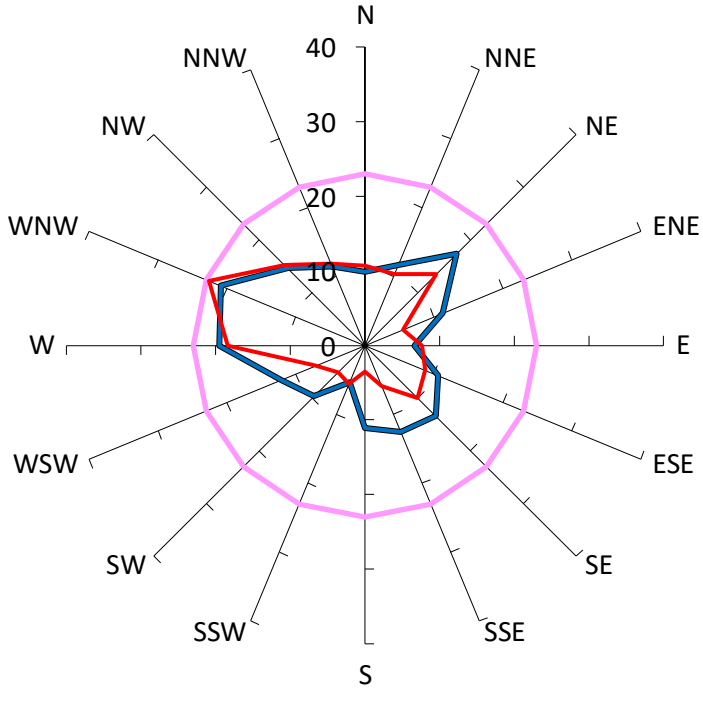
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	10%	21
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	9%	23

Results for Point 37a

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

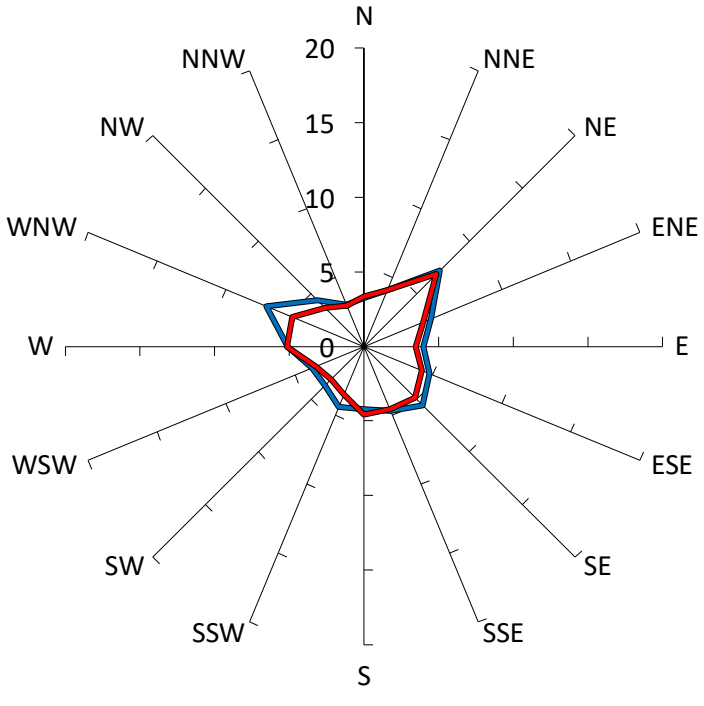


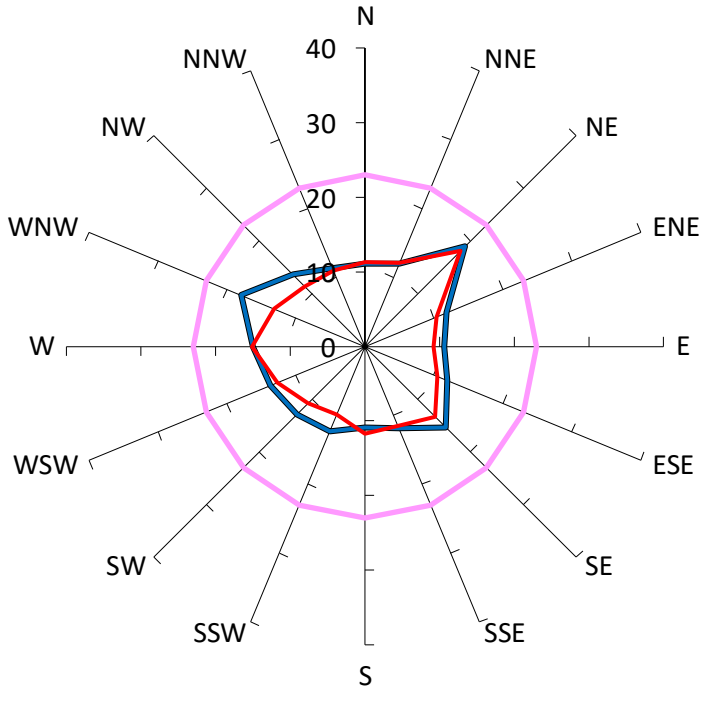
Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	2%	21
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	2%	23

Results for Point 38

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)





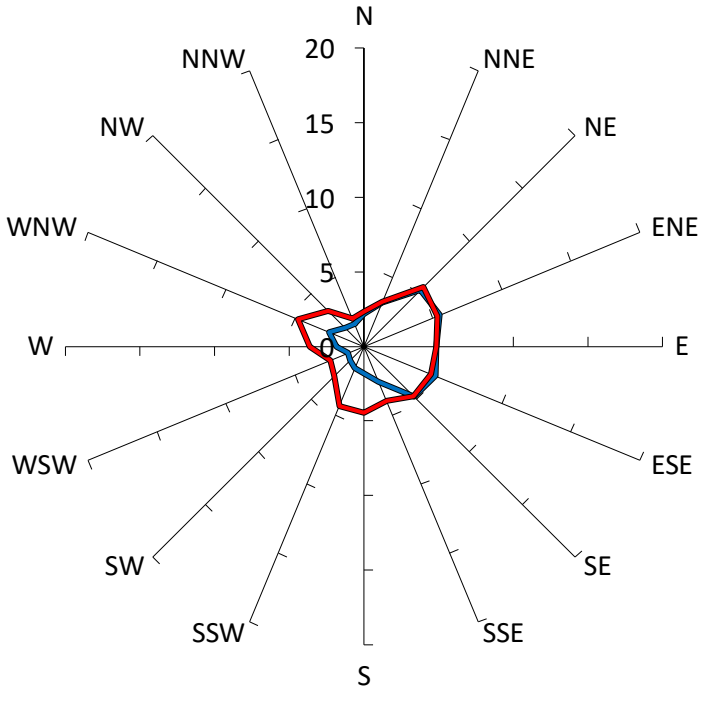
Comfort Criteria: 8m/s with 5% probability of exceedence

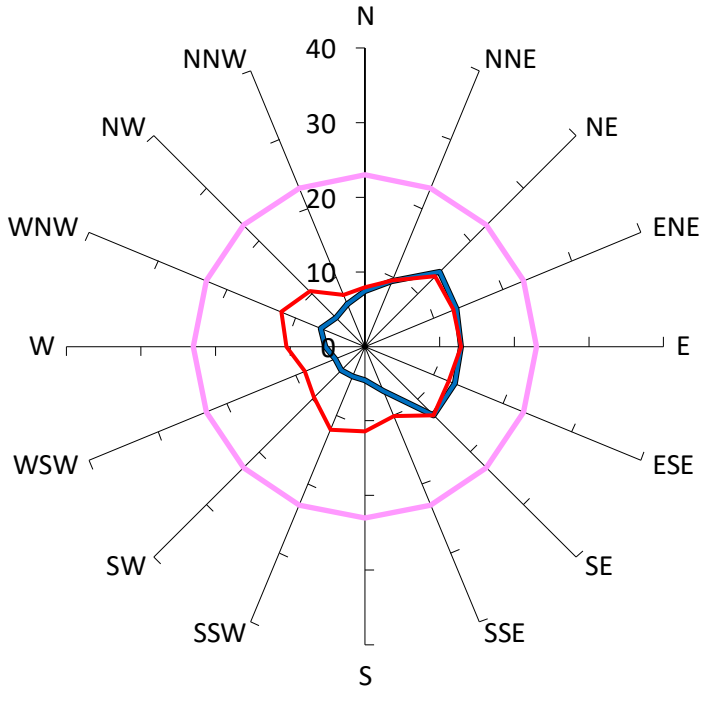
Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	2%	19
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	1%	18

Results for Point 39

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)





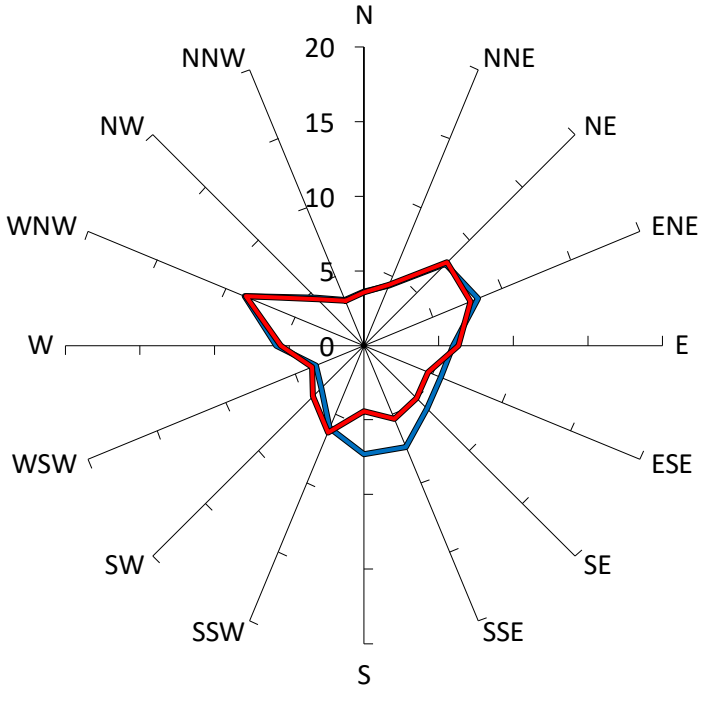
Comfort Criteria: 8m/s with 5% probability of exceedence

Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	< 1%	14
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	< 1%	13

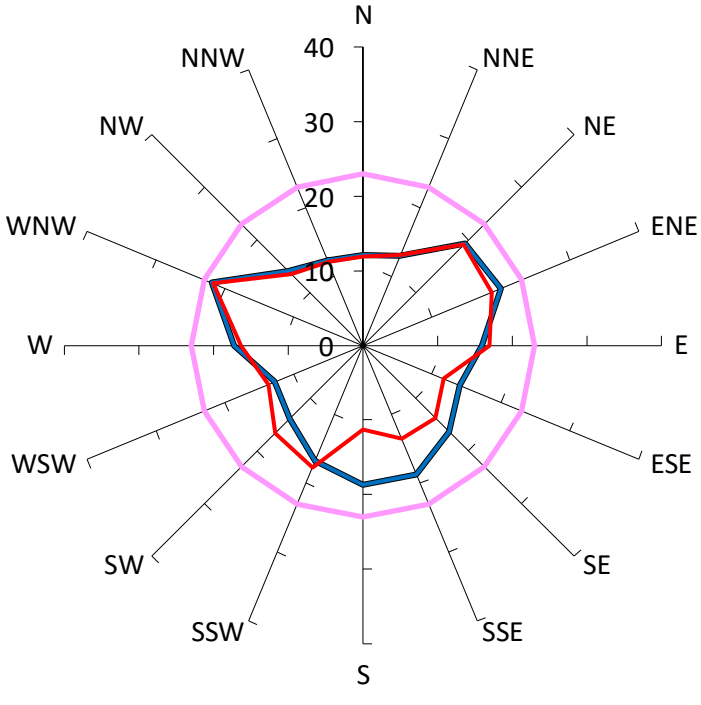
Results for Point 40

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

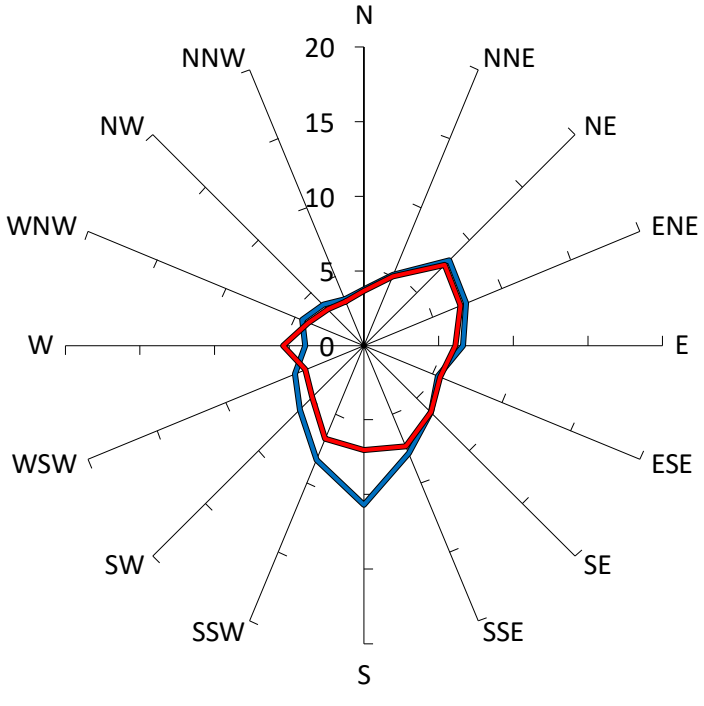


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	22%	22
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	17%	22

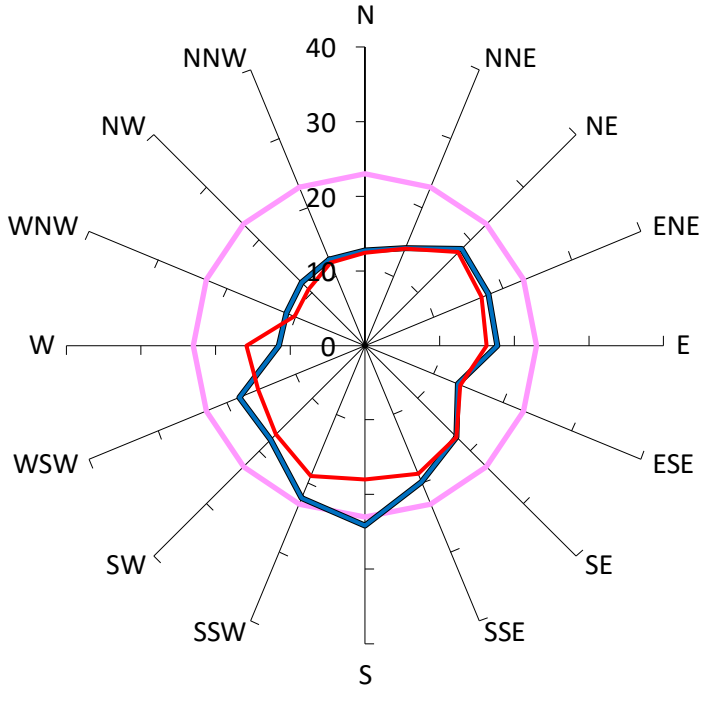
Results for Point 41

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

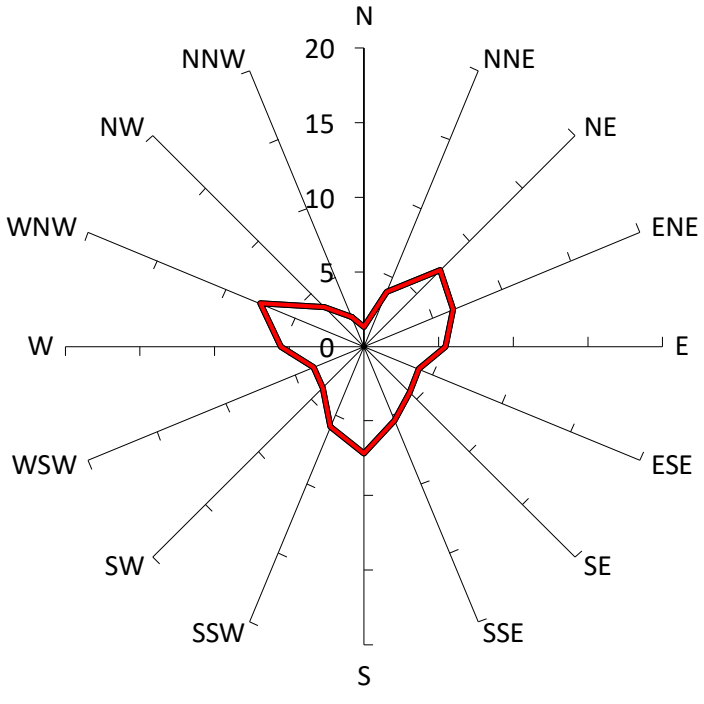


Safety Limit: 23m/s

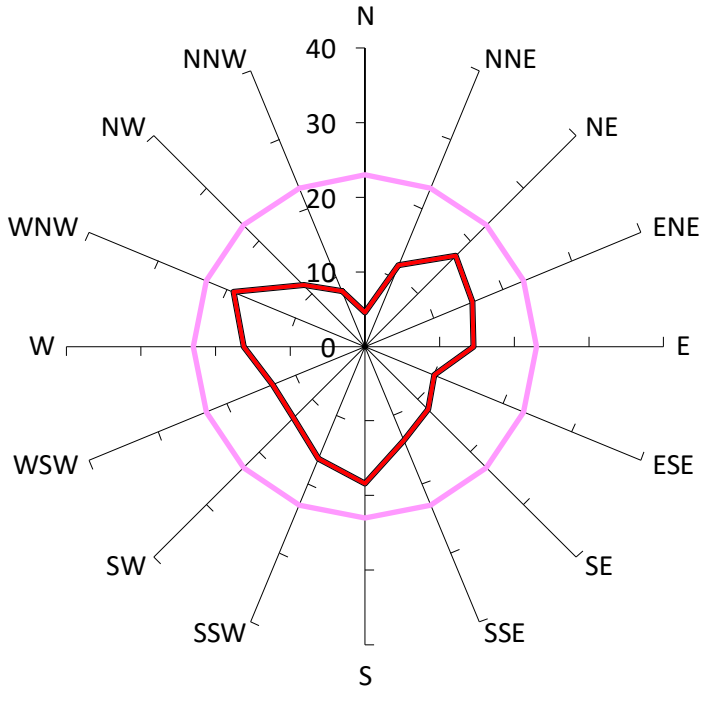
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	22%	24
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	18%	19

Results for Point 42

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

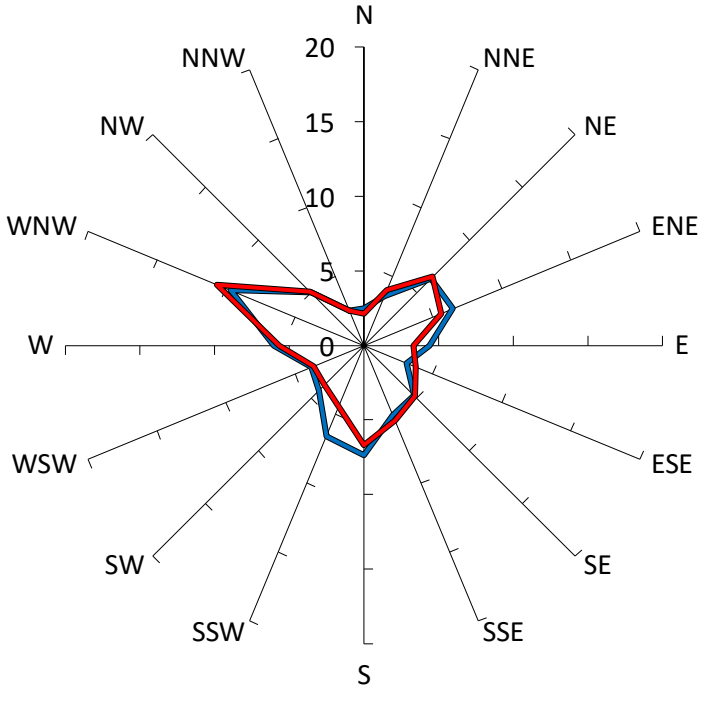


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 and Stage 2 Cases.	14%	19
With development "as proposed", no vegetation or other treatments. Stage 1 and Stage 2 Cases.	14%	19

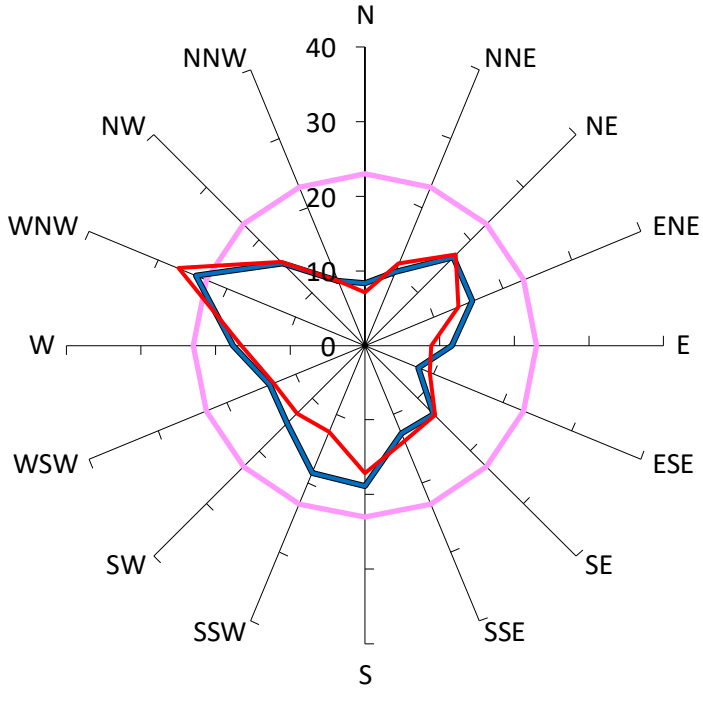
Results for Point 43

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

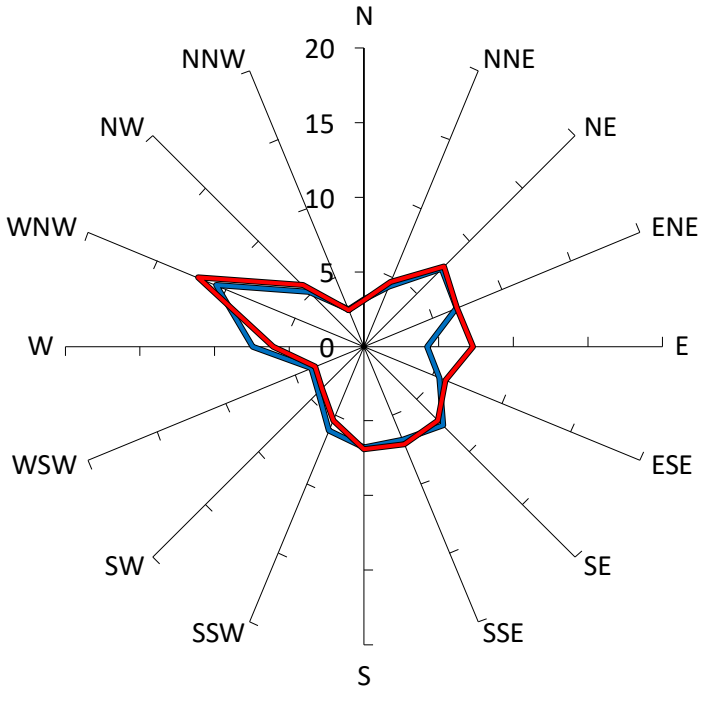


Safety Limit: 23m/s

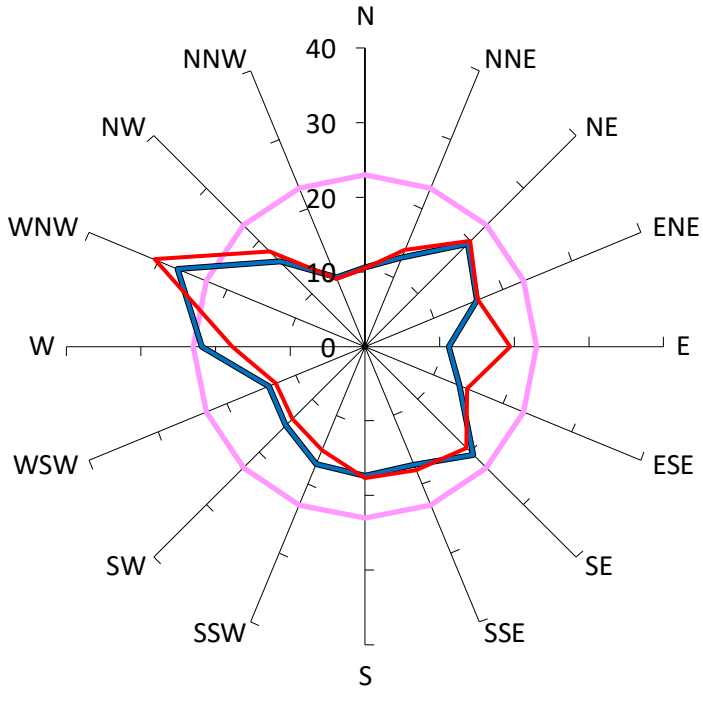
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	18%	24
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	15%	27

Results for Point 44

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

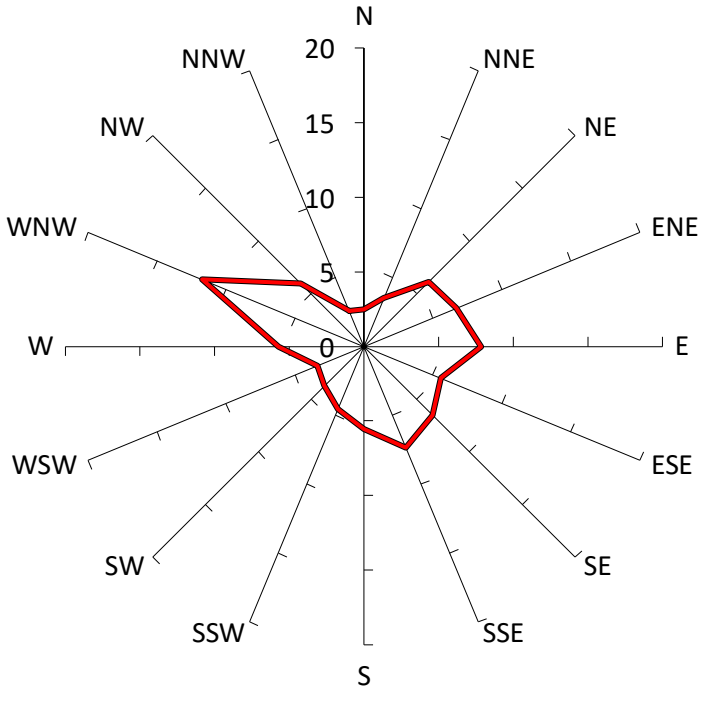


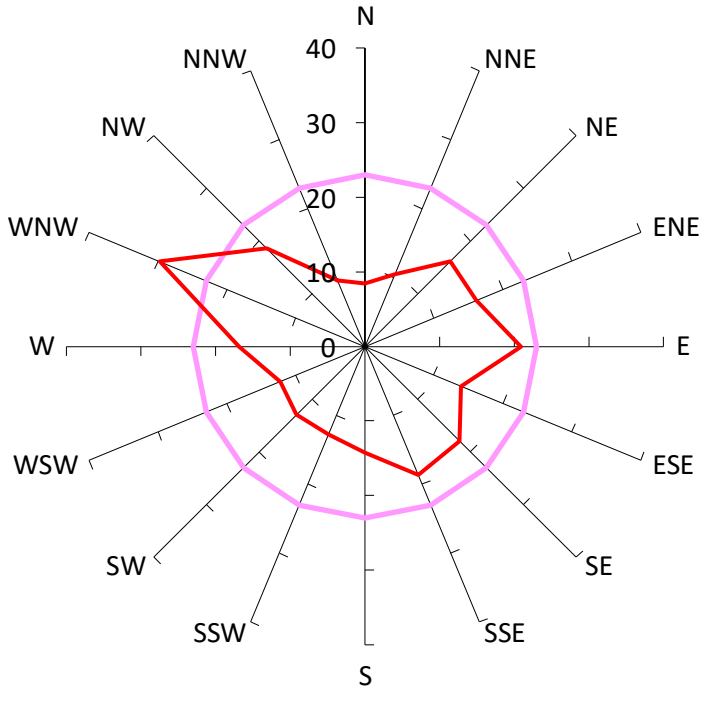
Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	24%	27
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	26%	30

Results for Point 45

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)





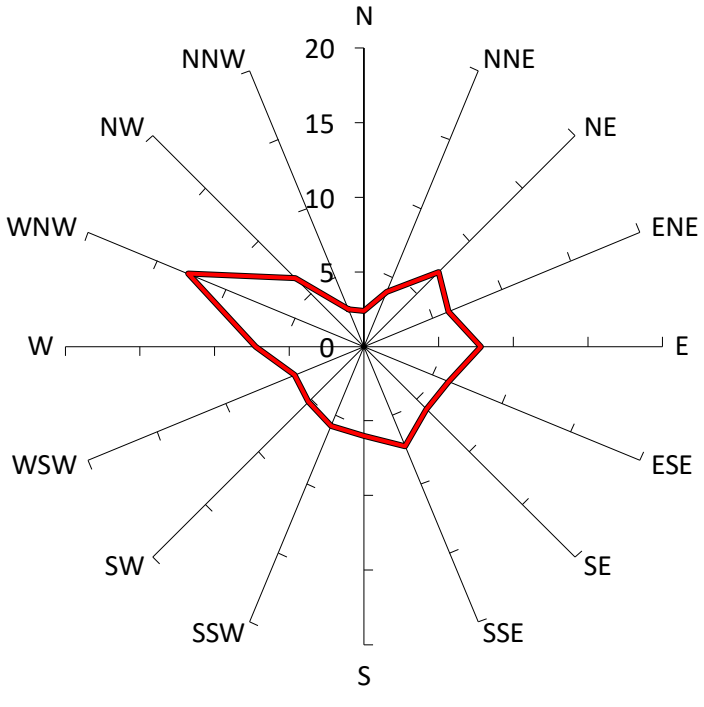
Comfort Criteria: 6m/s with 5% probability of exceedence

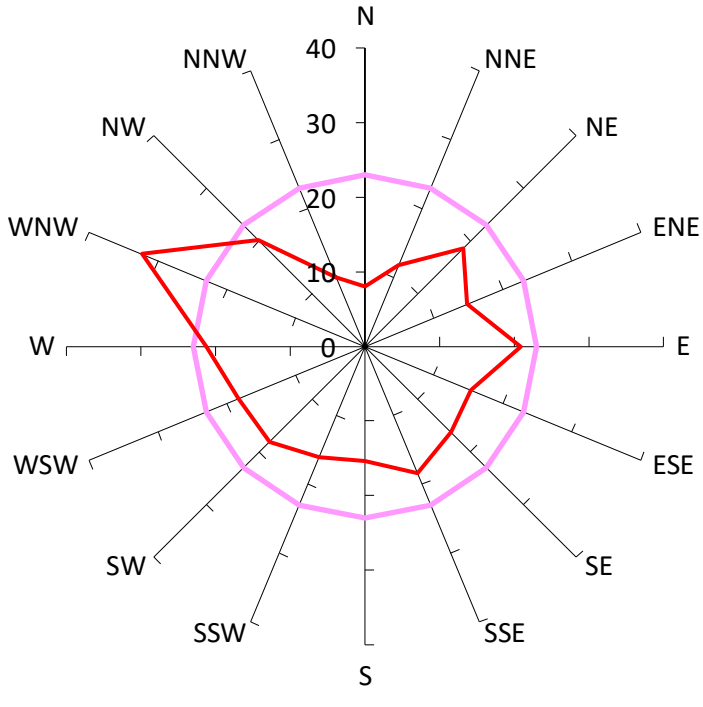
Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	22%	30

Results for Point 46

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)





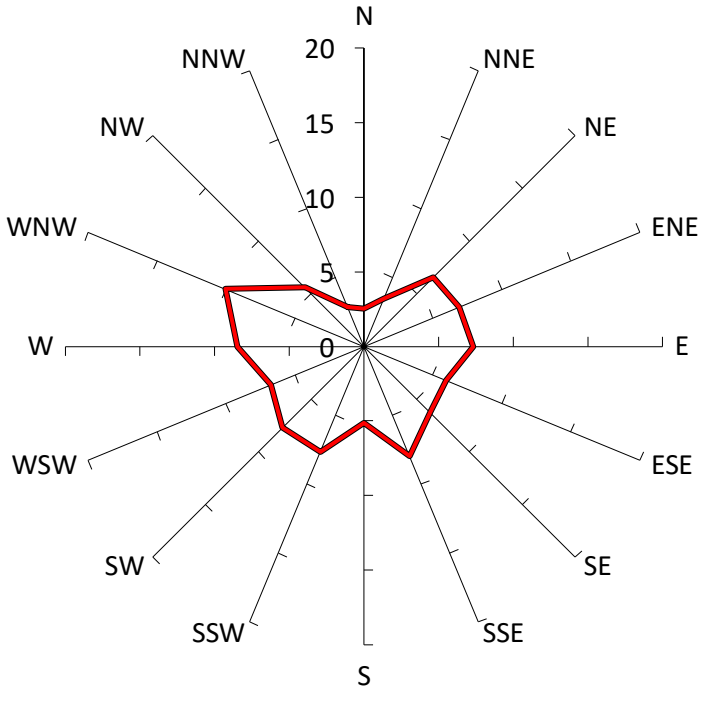
Comfort Criteria: 6m/s with 5% probability of exceedence

Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	26%	32

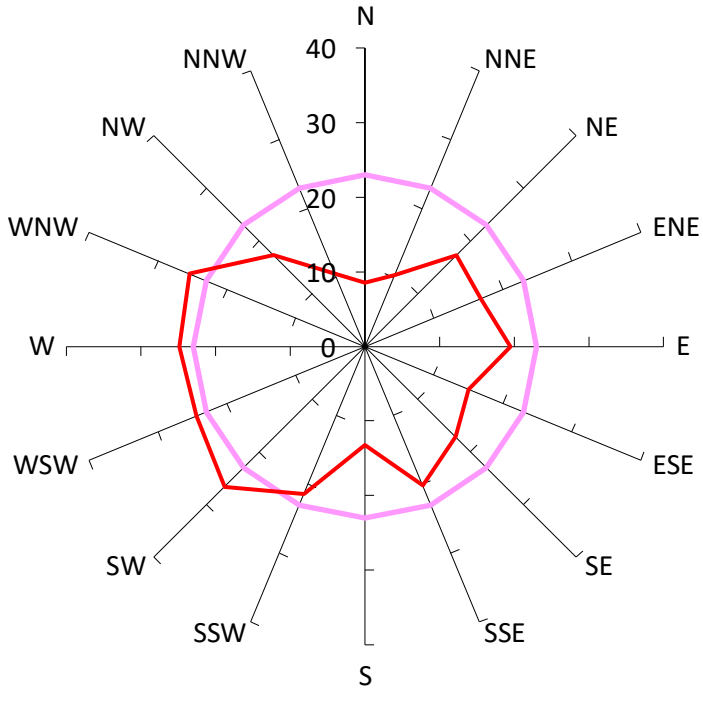
Results for Point 47

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

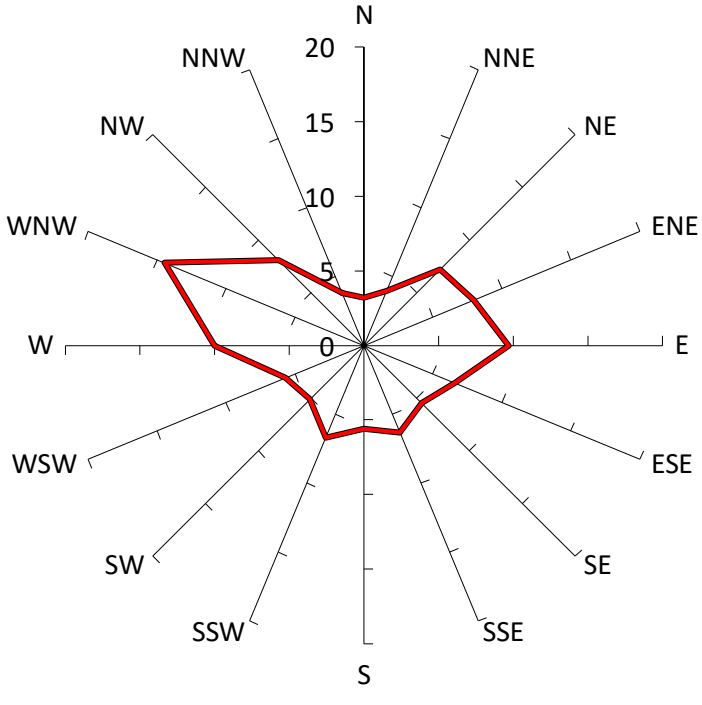


Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	27%	27

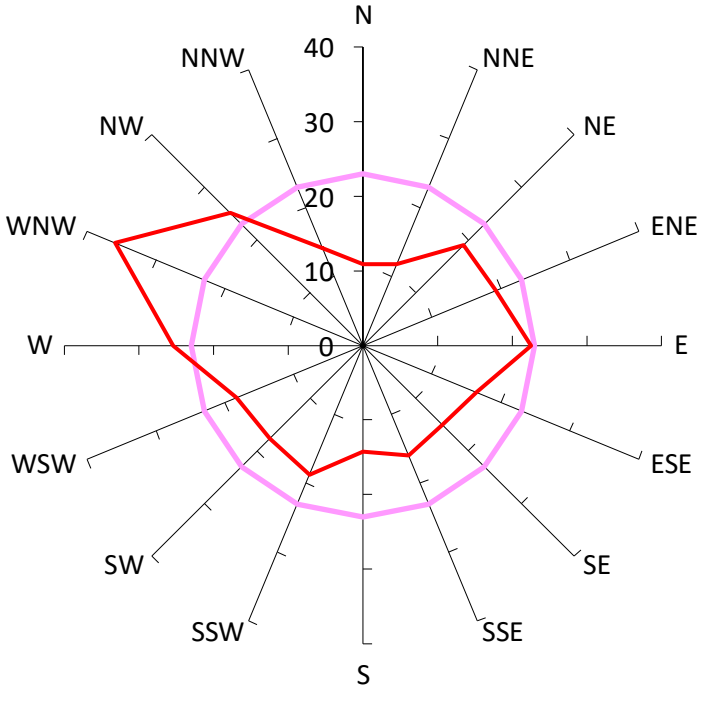
Results for Point 48

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

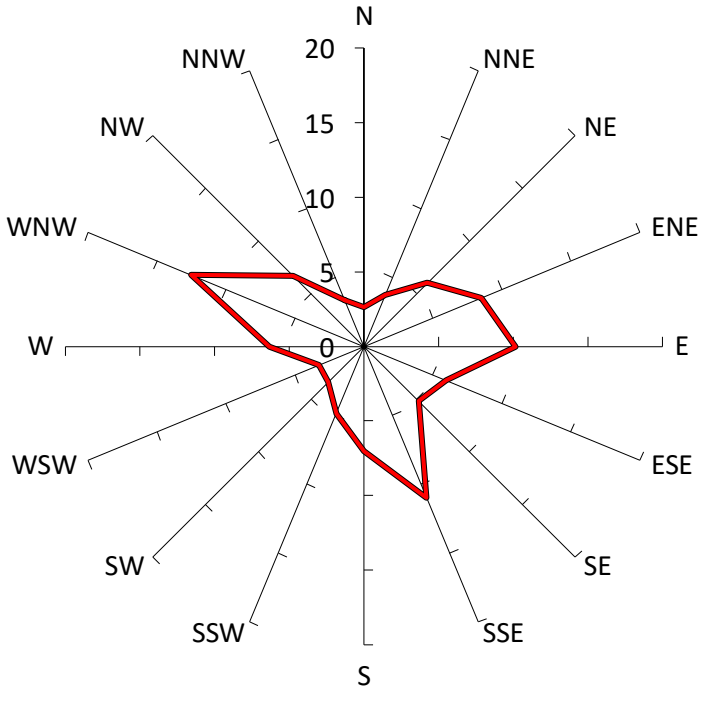


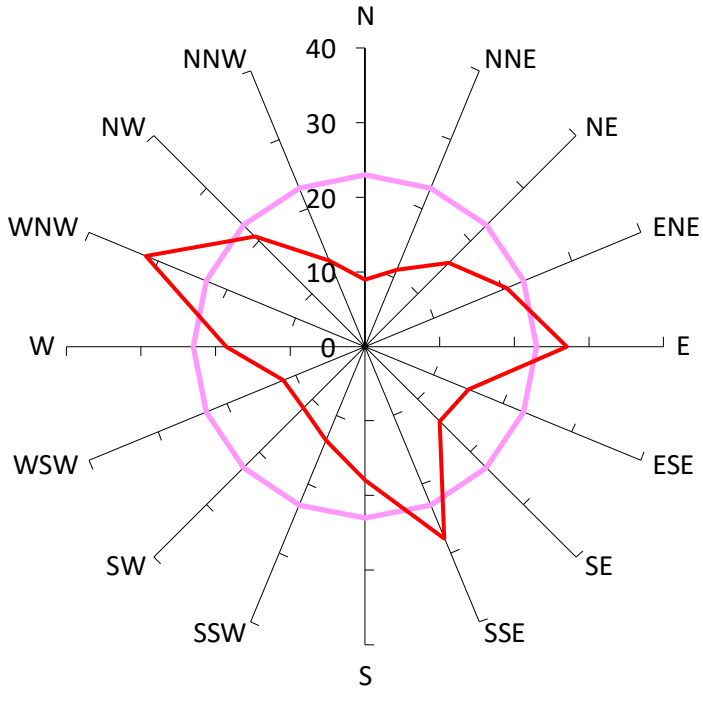
Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	18%	36

Results for Point 49

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)





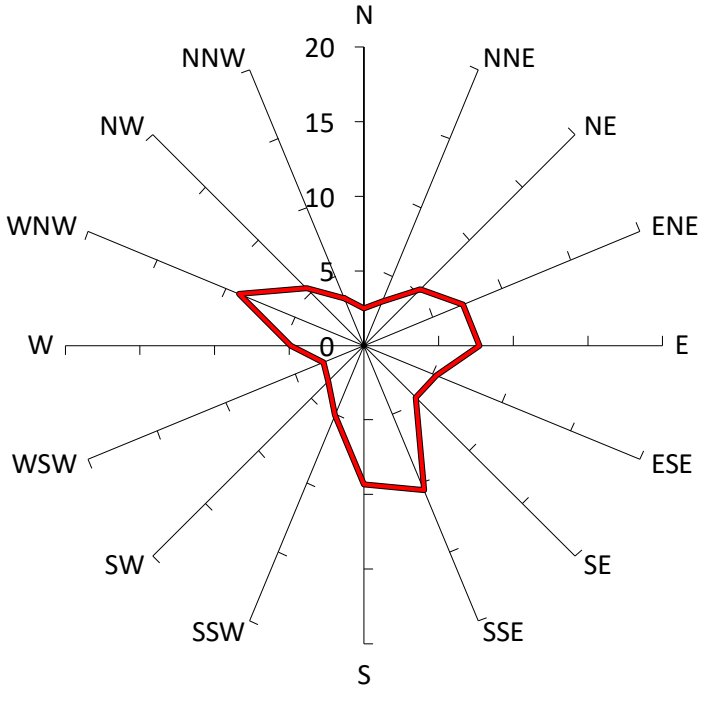
Comfort Criteria: 6m/s with 5% probability of exceedence

Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	25%	32

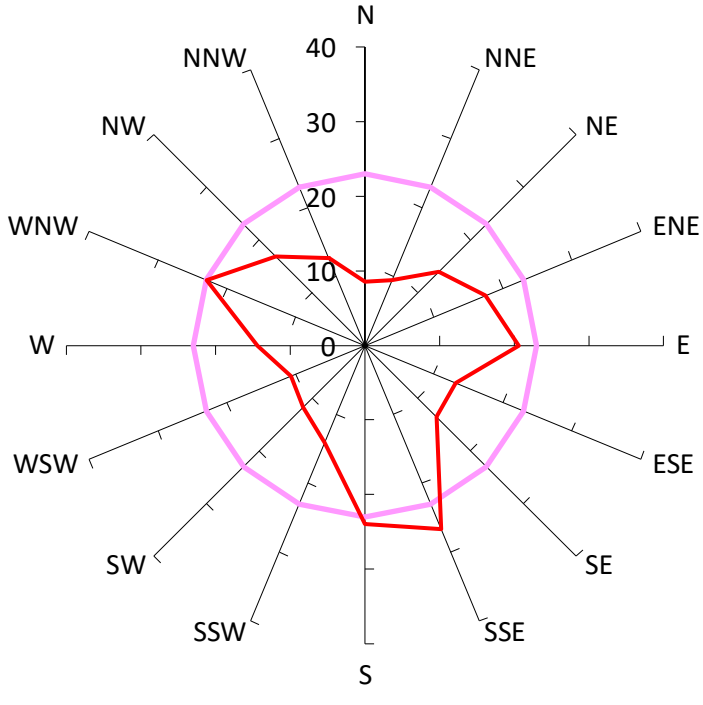
Results for Point 50

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

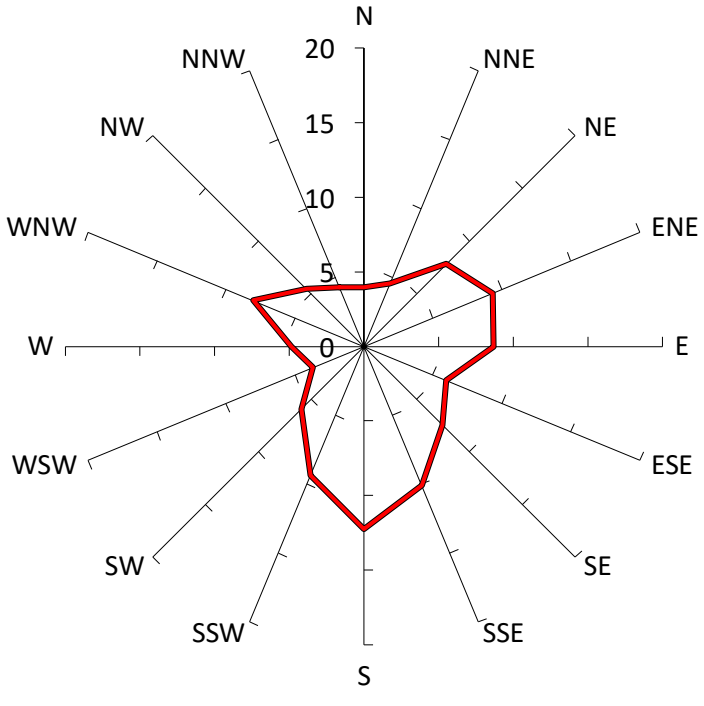


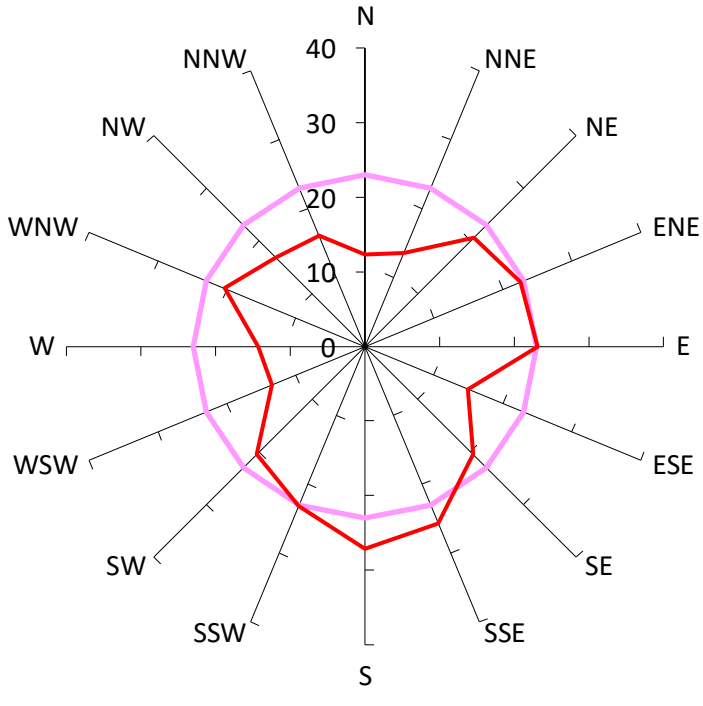
Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	20%	27

Results for Point 51

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)





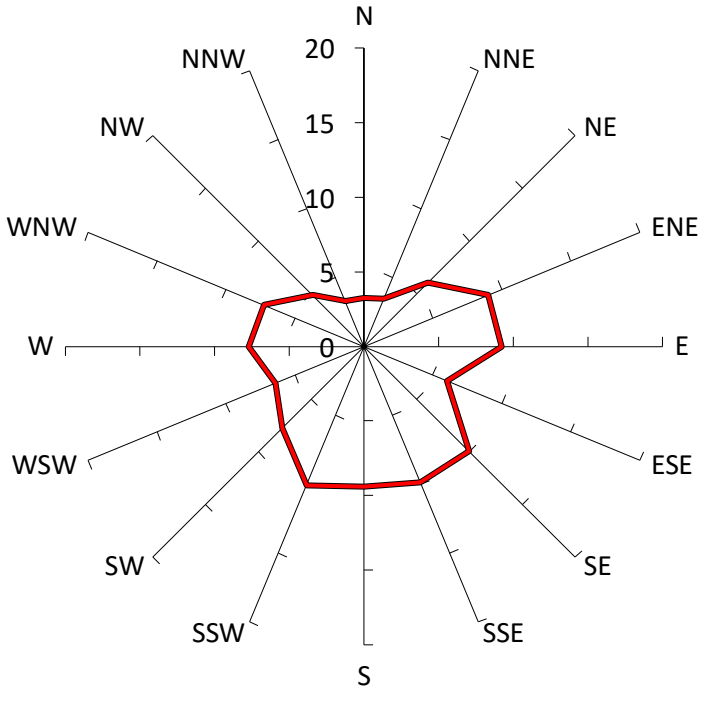
Comfort Criteria: 8m/s with 5% probability of exceedence

Safety Limit: 23m/s

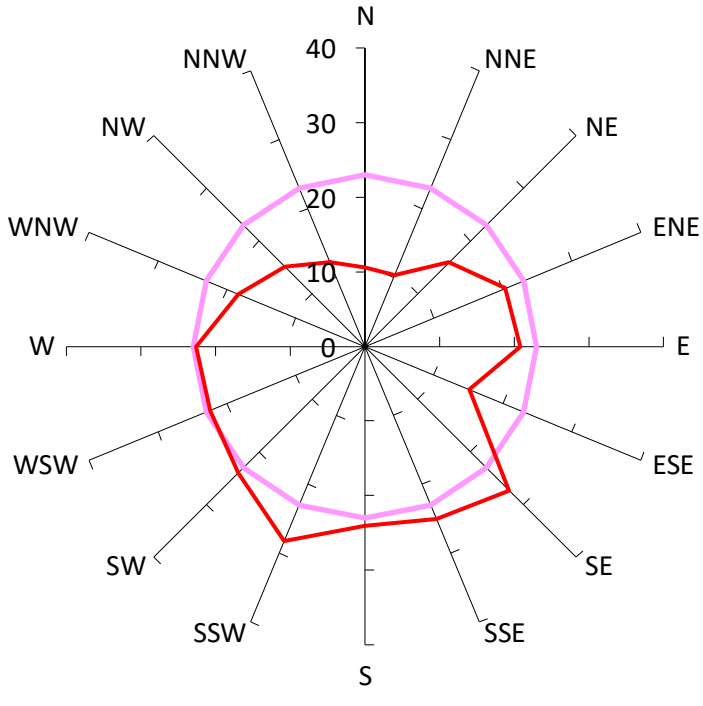
	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	16%	27

Results for Point 52

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

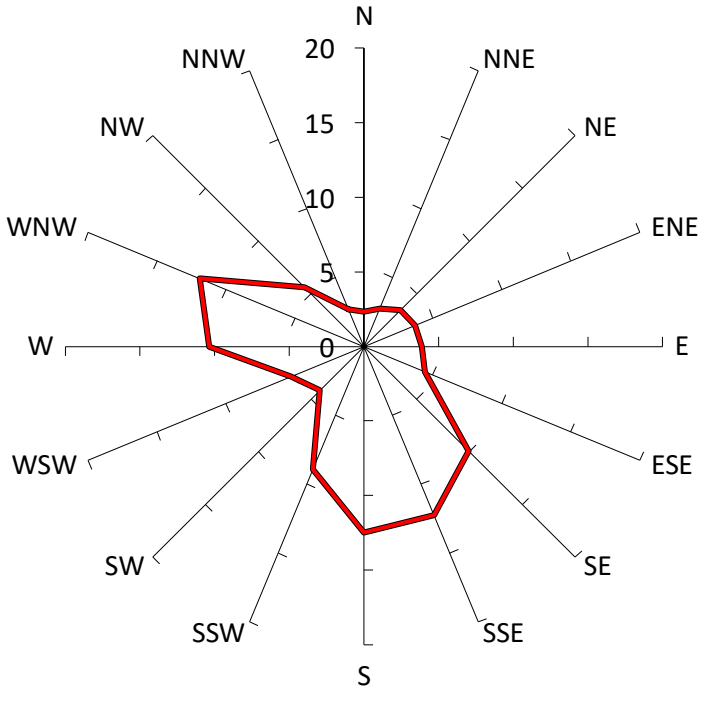


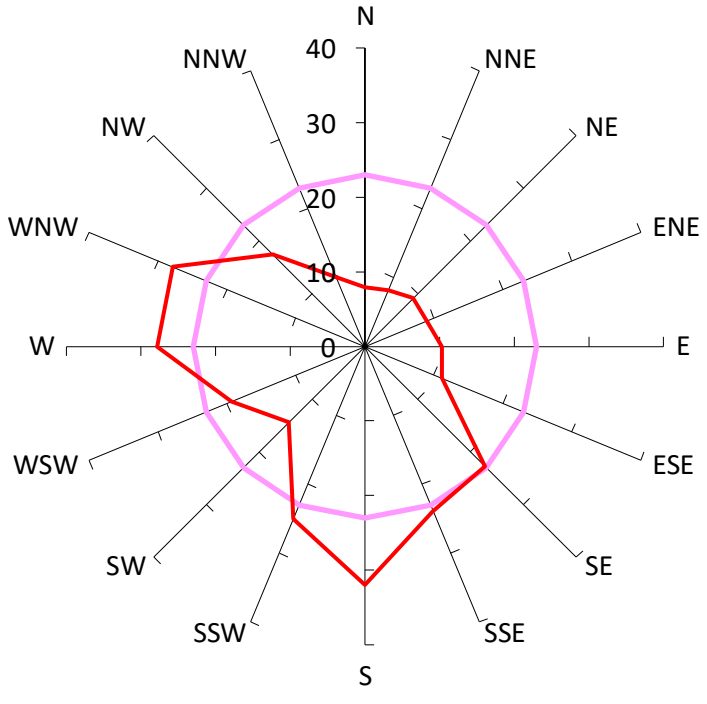
Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	18%	28

Results for Point 54

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)





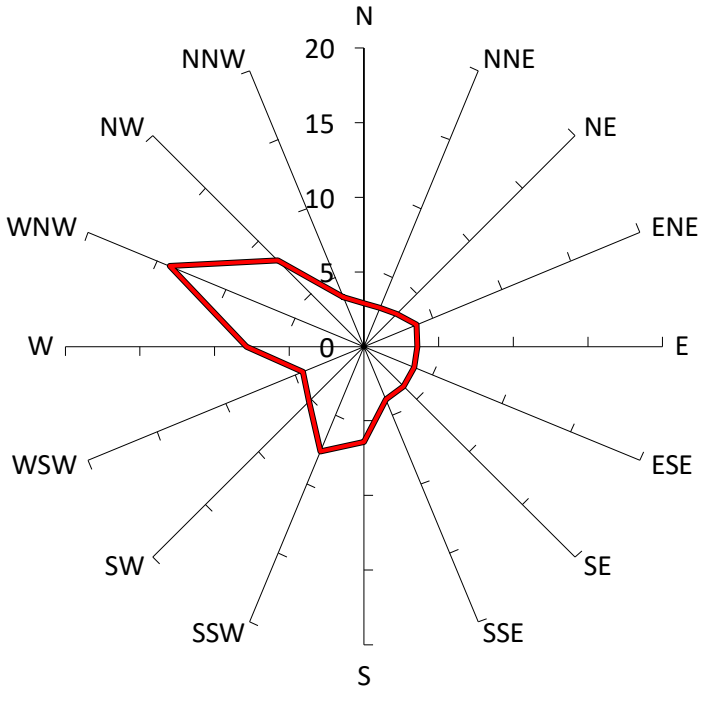
Comfort Criteria: 8m/s with 5% probability of exceedence

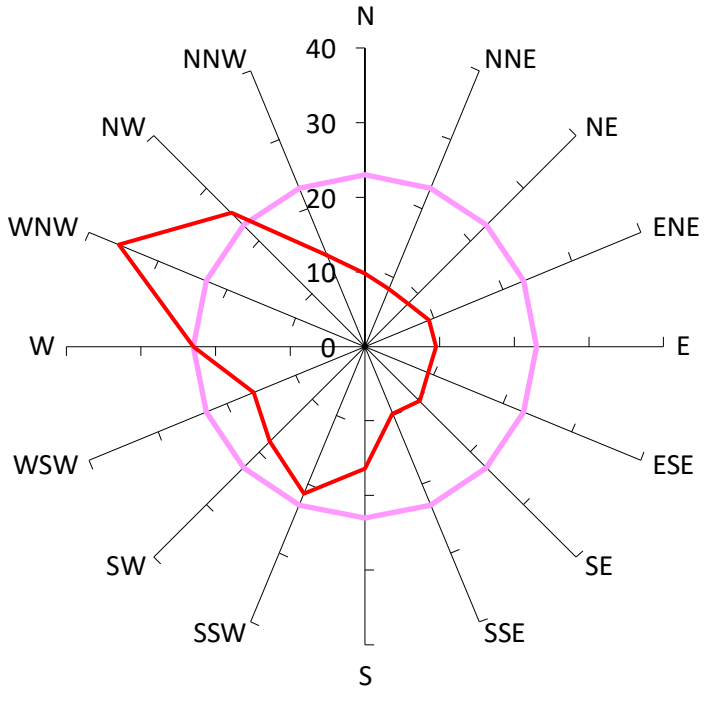
Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	20%	32

Results for Point 55

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)





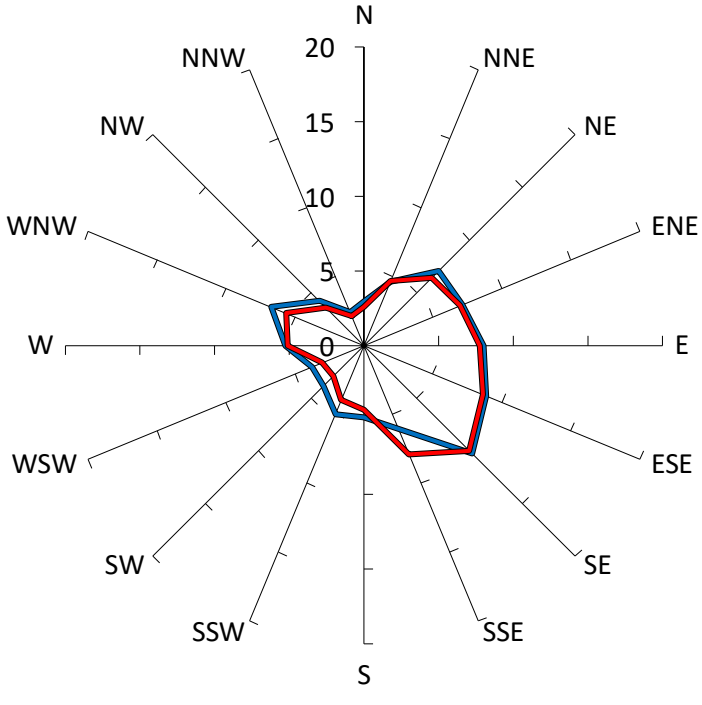
Comfort Criteria: 8m/s with 5% probability of exceedence

Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	12%	36

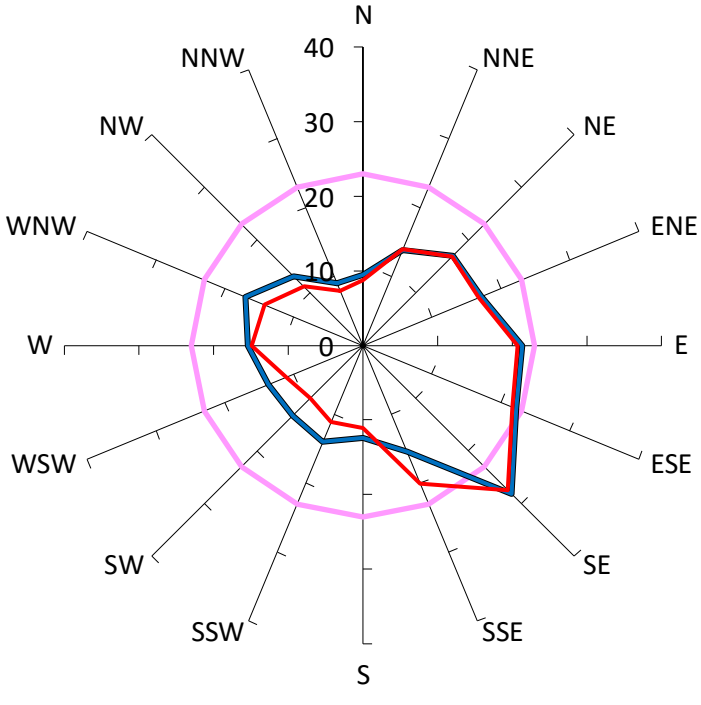
Results for Point 57

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

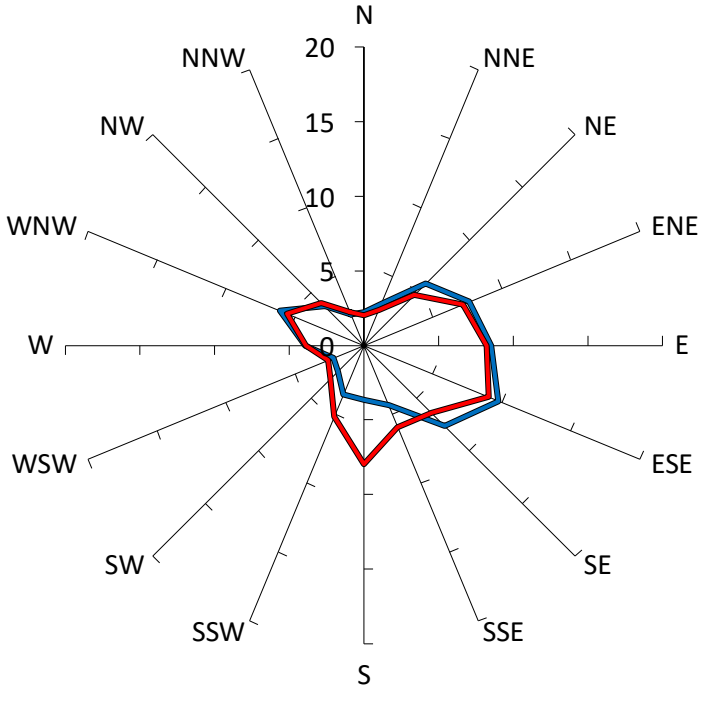


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	7%	28
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	7%	27

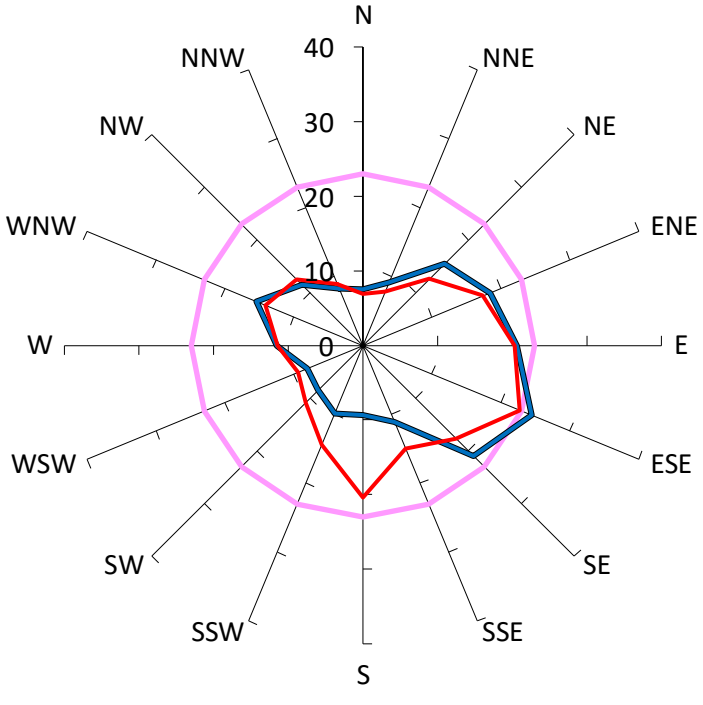
Results for Point 58

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

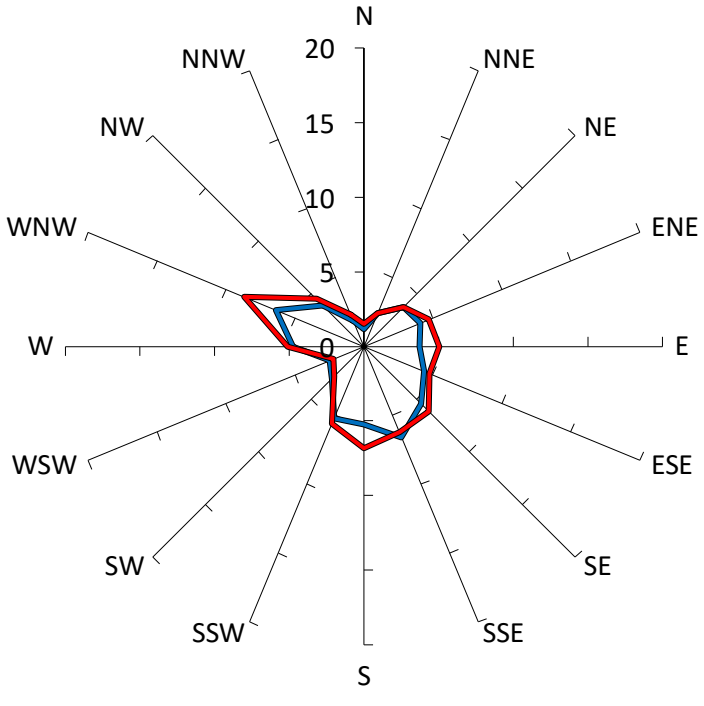


Safety Limit: 23m/s

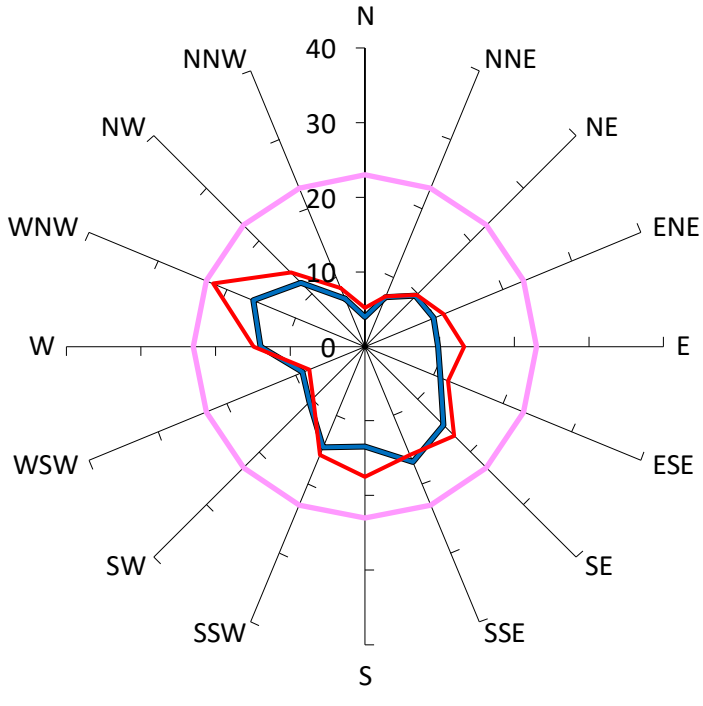
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	5%	24
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	5%	23

Results for Point 59

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

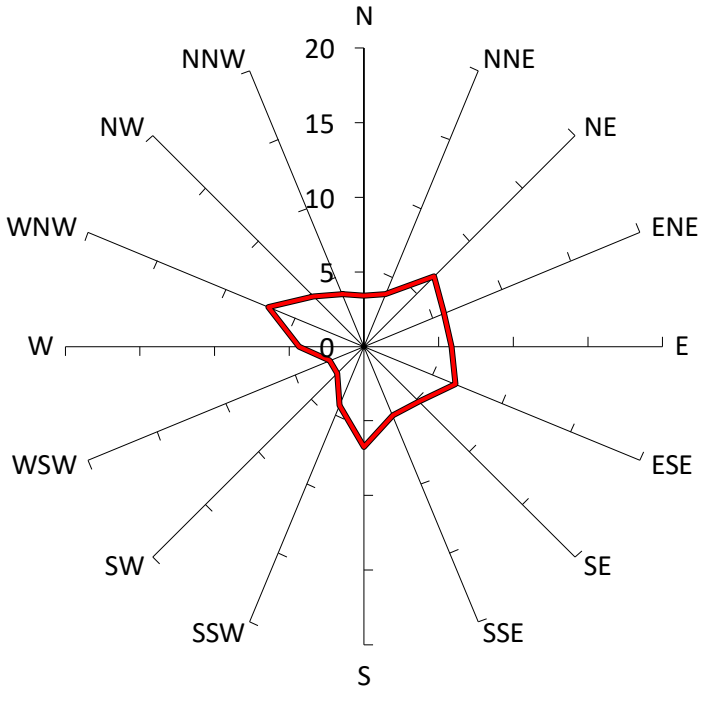


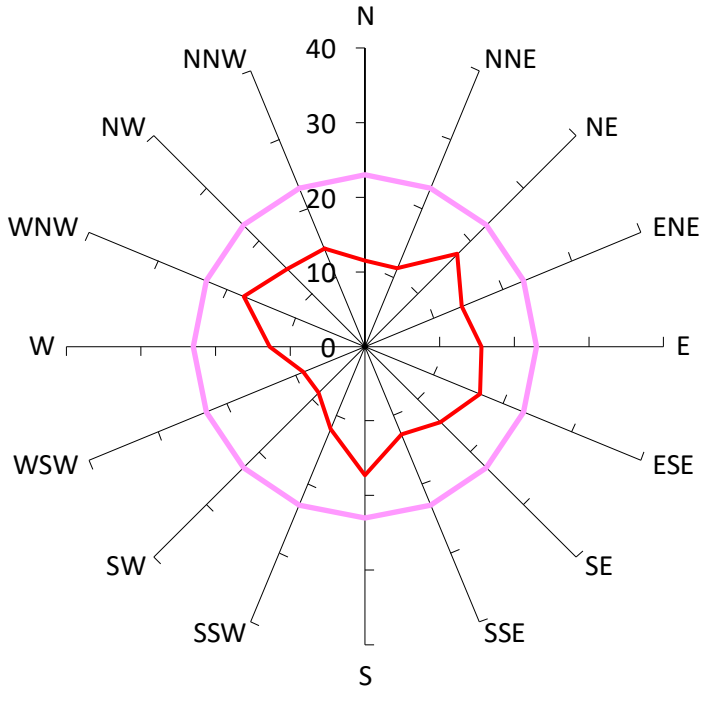
Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	1%	17
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	3%	22

Results for Point 60

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)





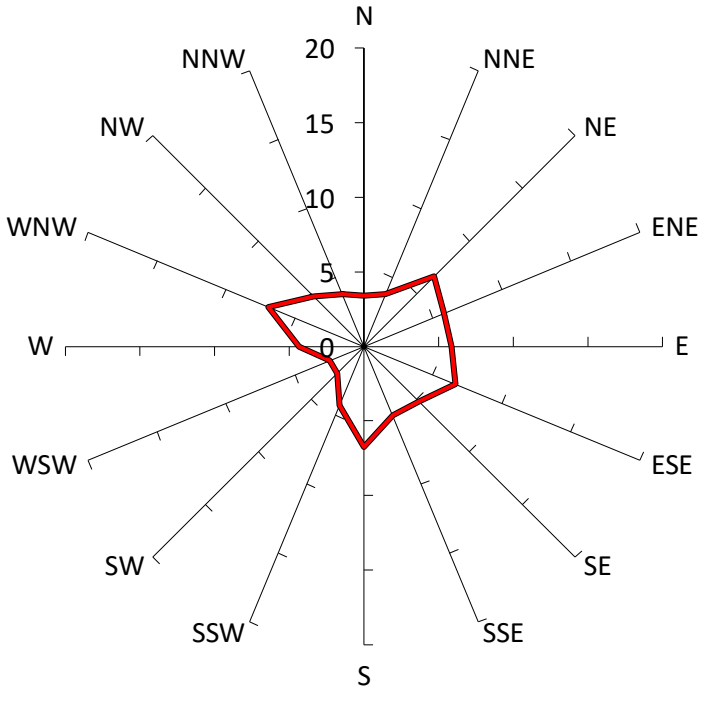
Comfort Criteria: 8m/s with 5% probability of exceedence

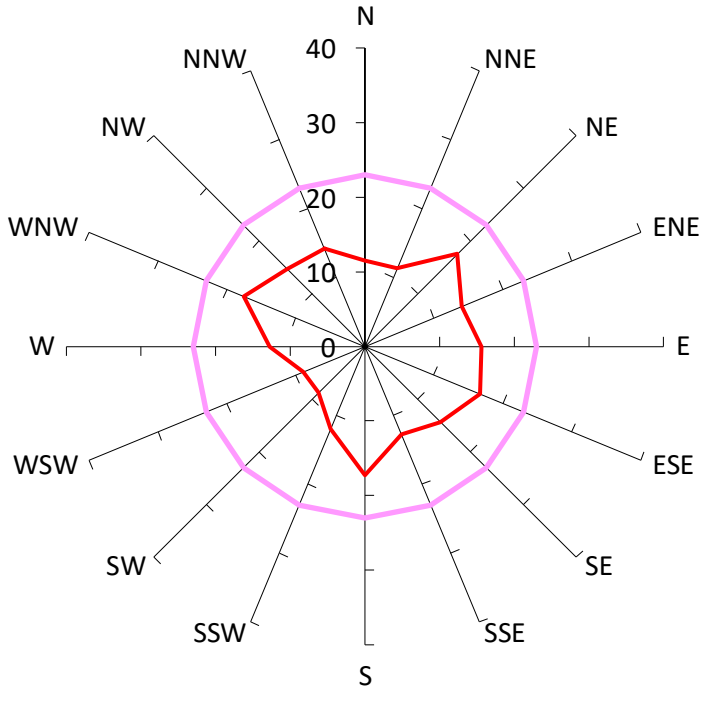
Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	2%	18

Results for Point 60a

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)





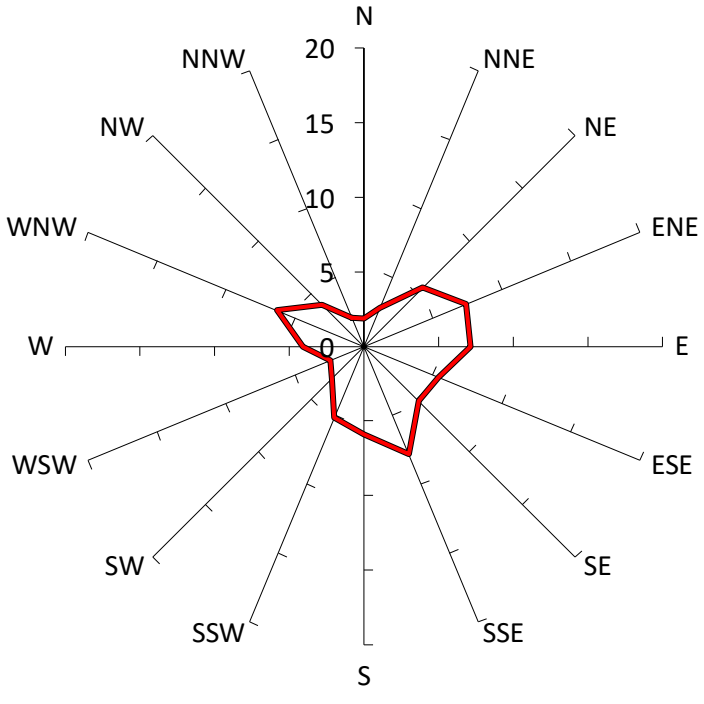
Comfort Criteria: 8m/s with 5% probability of exceedence

Safety Limit: 23m/s

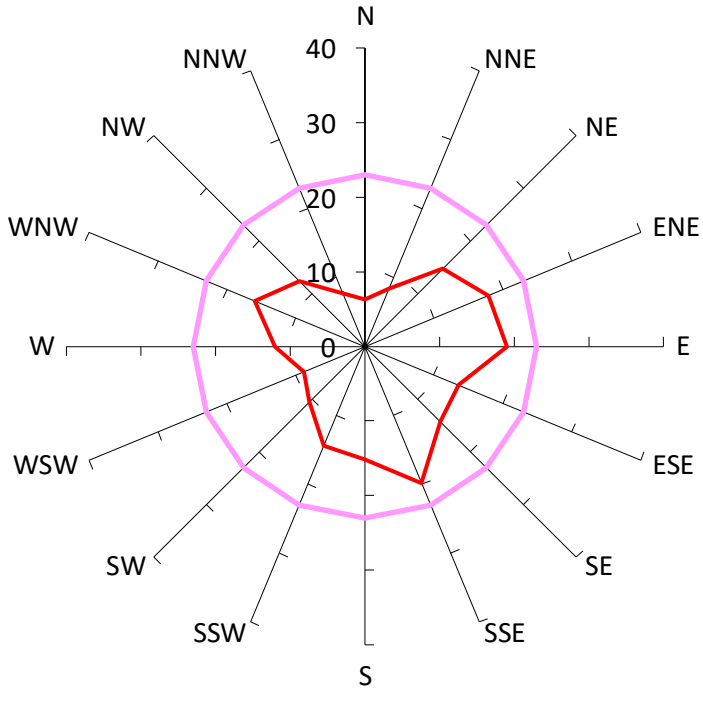
	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	2%	18

Results for Point 61

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

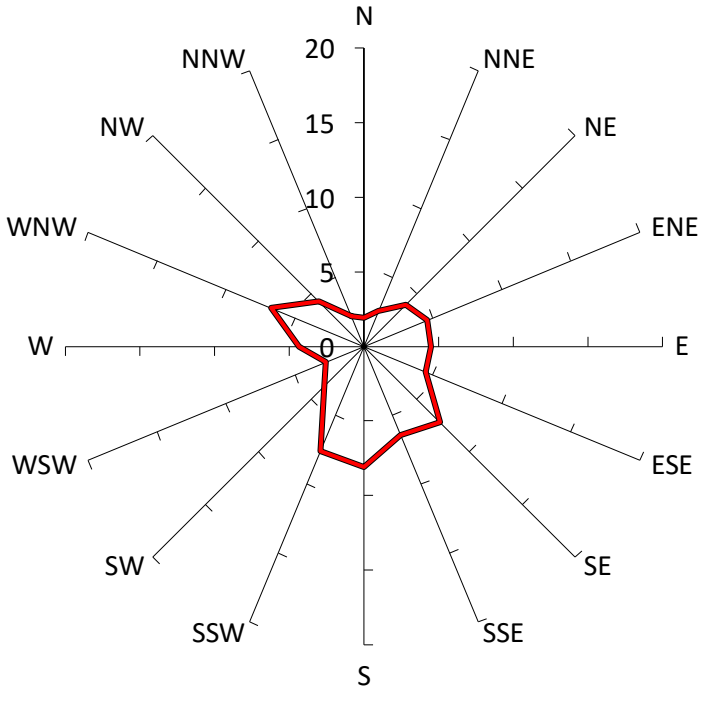


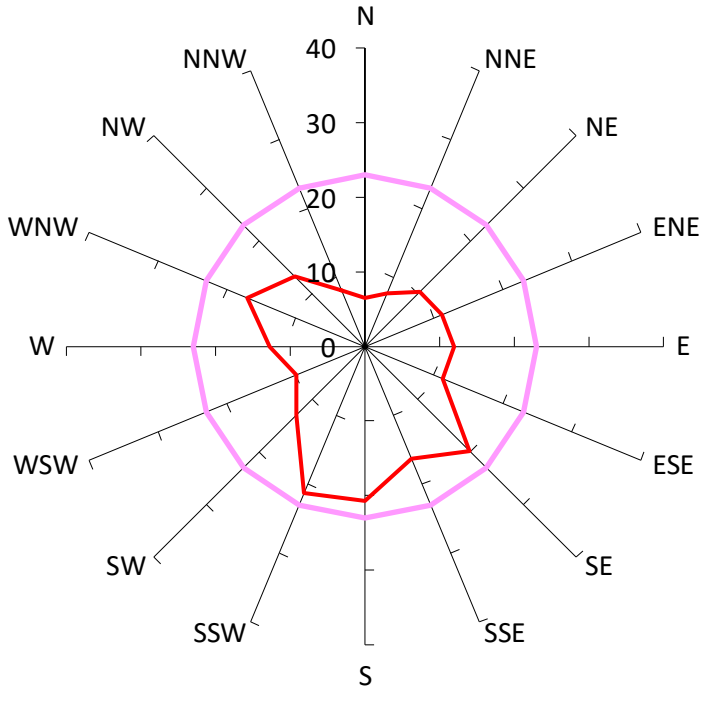
Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	3%	20

Results for Point 62

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)





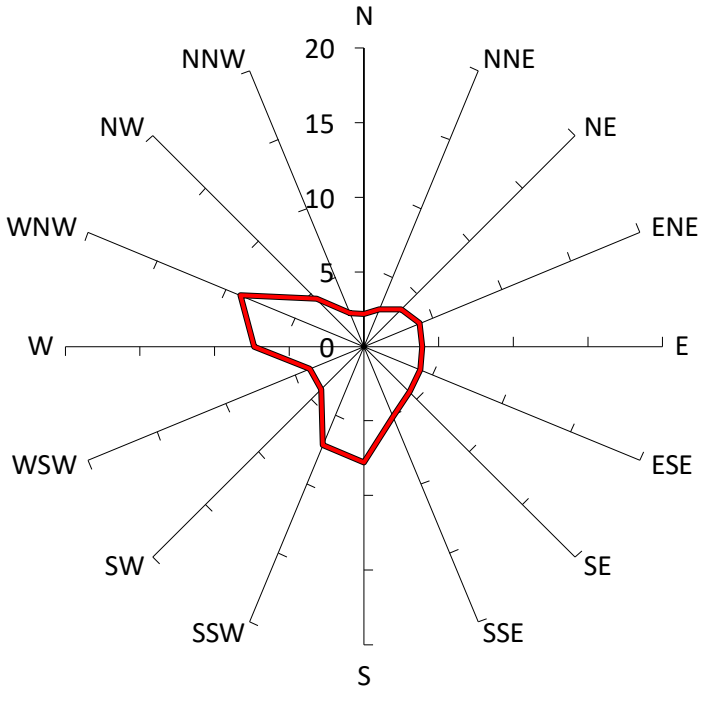
Comfort Criteria: 8m/s with 5% probability of exceedence

Safety Limit: 23m/s

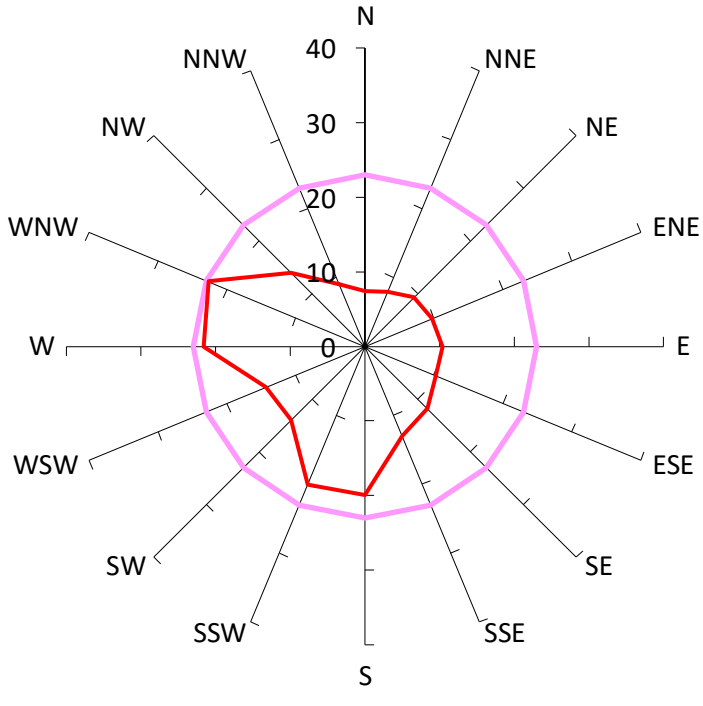
	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	3%	21

Results for Point 63

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

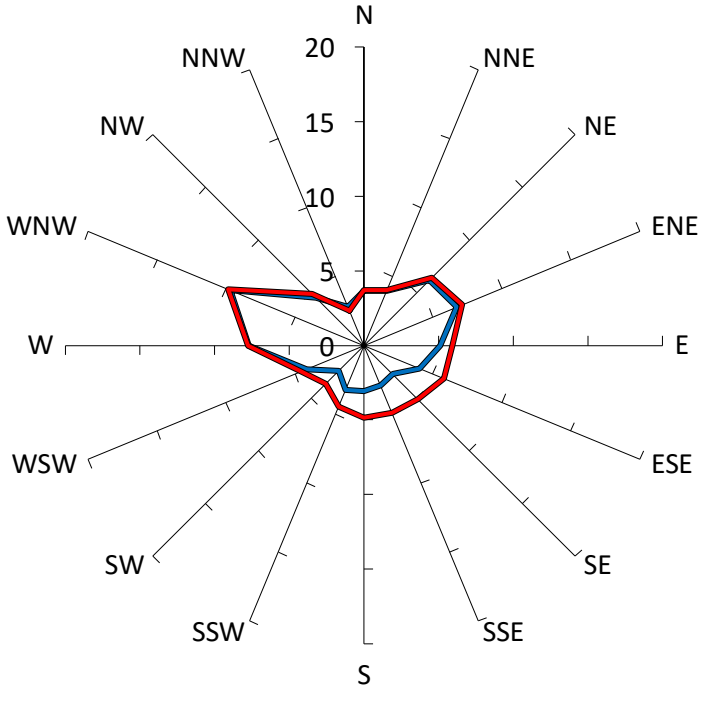


Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	4%	23

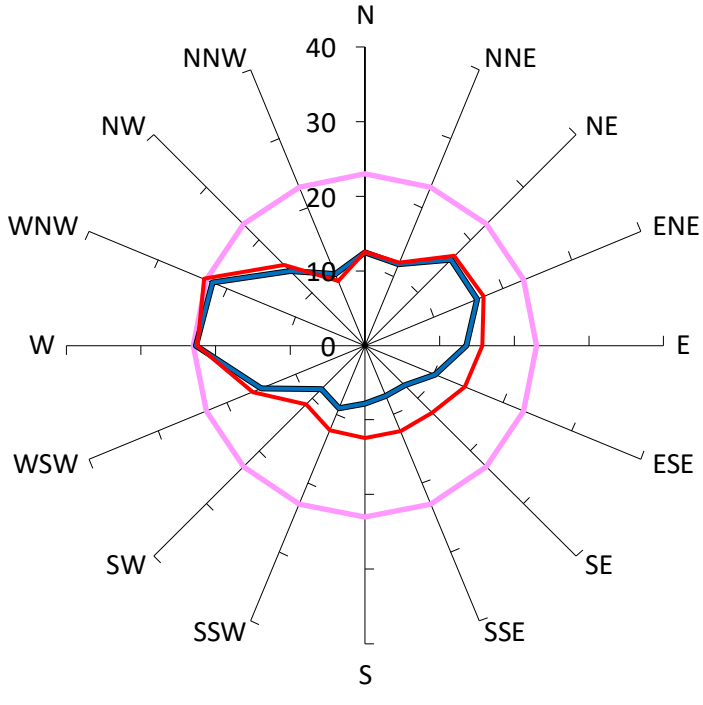
Results for Point 64

Gust Equivalent Mean (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

Maximum Gust (m/s)

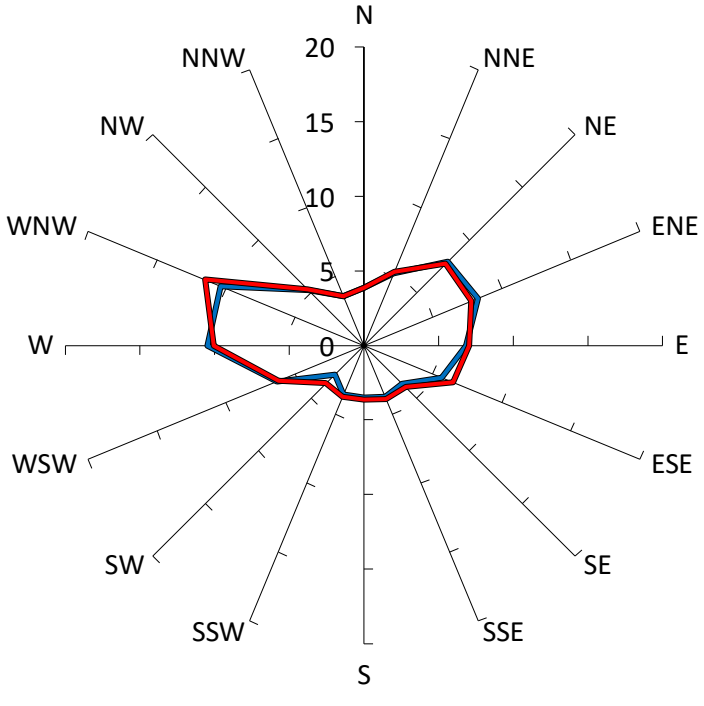


Safety Limit: 23m/s

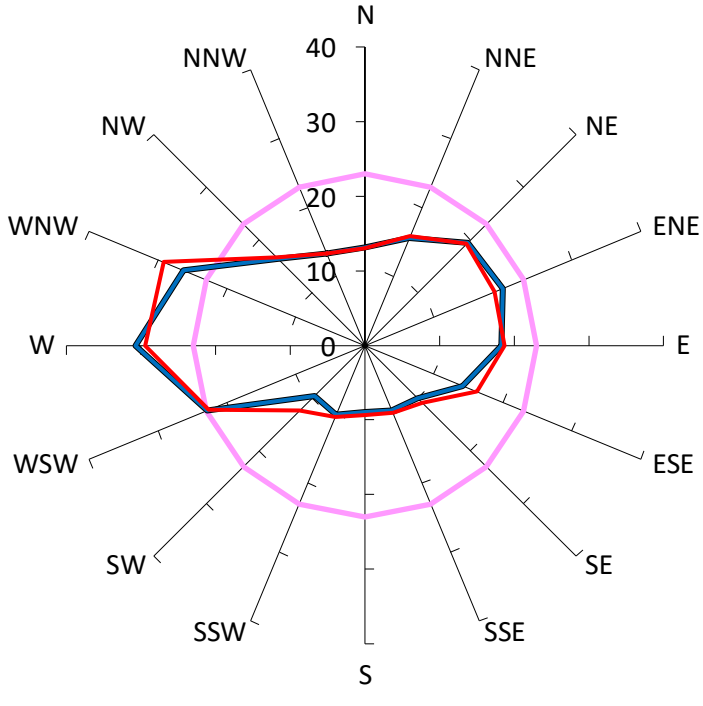
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	15%	23
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	18%	23

Results for Point 65

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 6m/s with 5% probability of exceedence

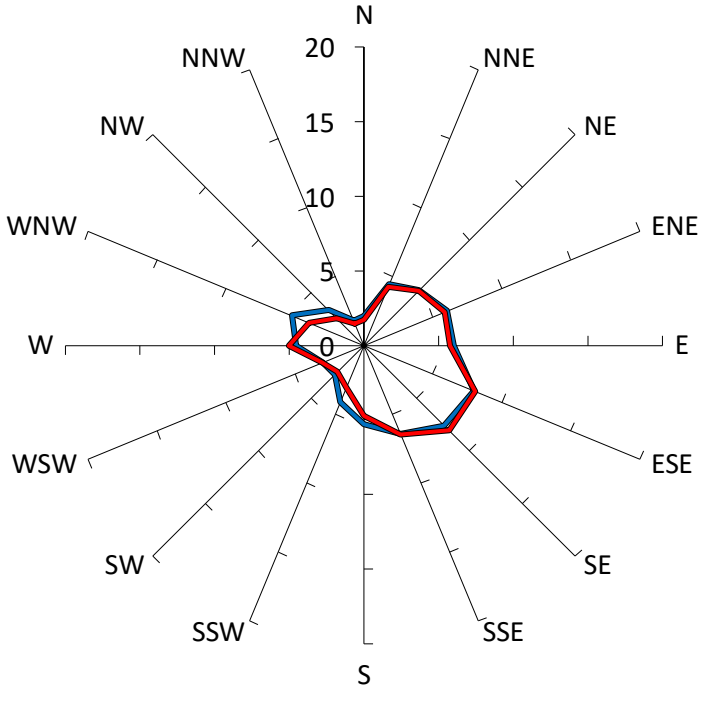


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Standing Criterion (6m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	23%	31
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	24%	29

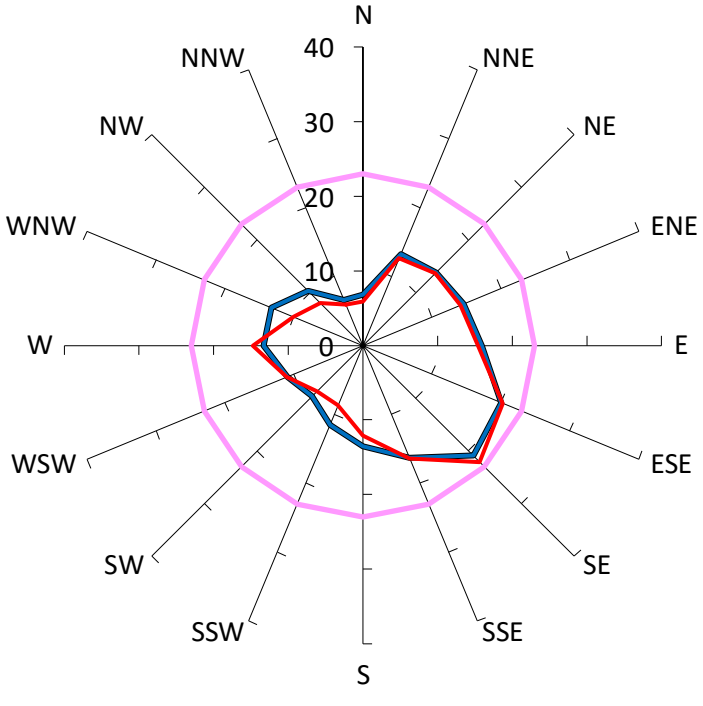
Results for Point 66

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

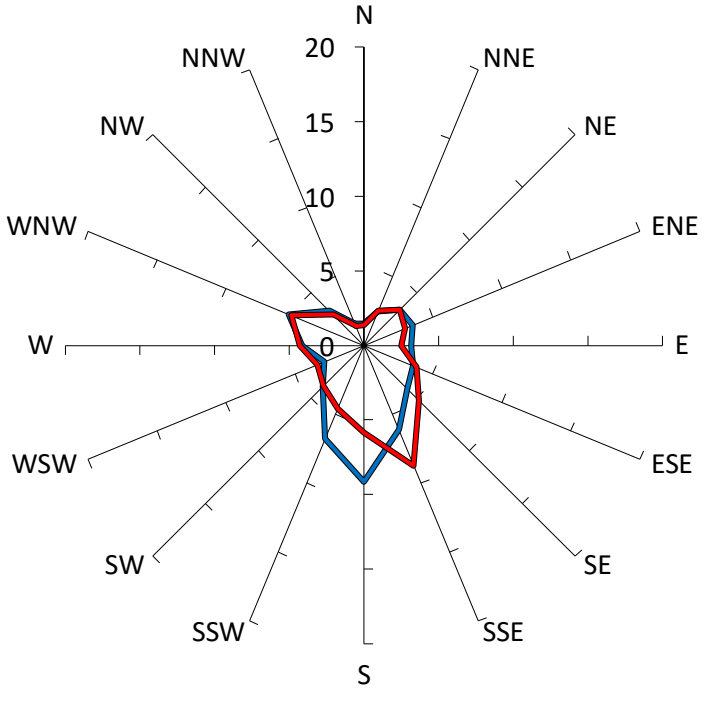


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	2%	21
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	2%	22

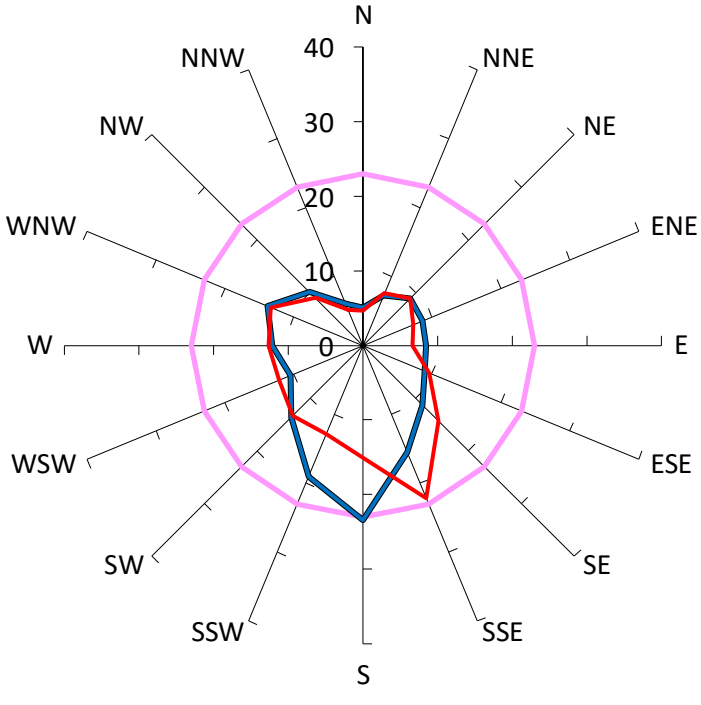
Results for Point 67

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

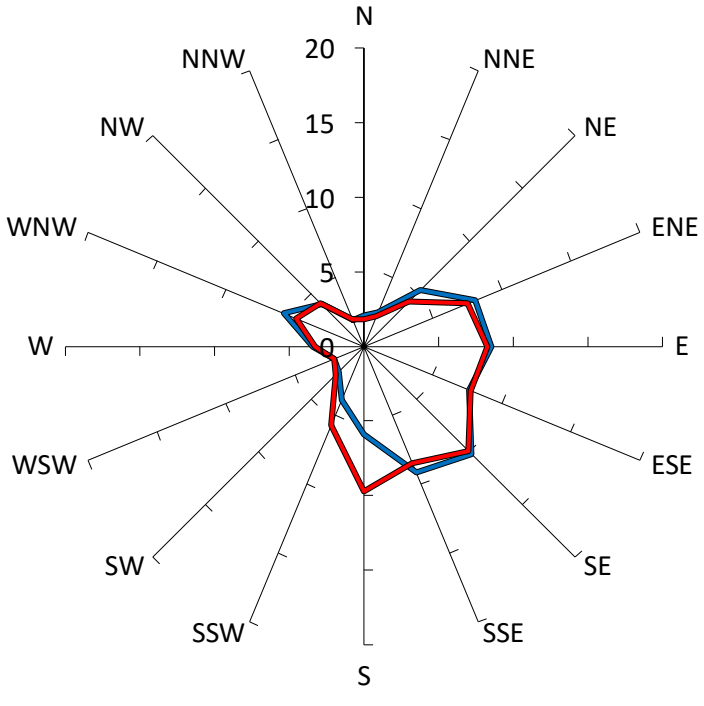


Safety Limit: 23m/s

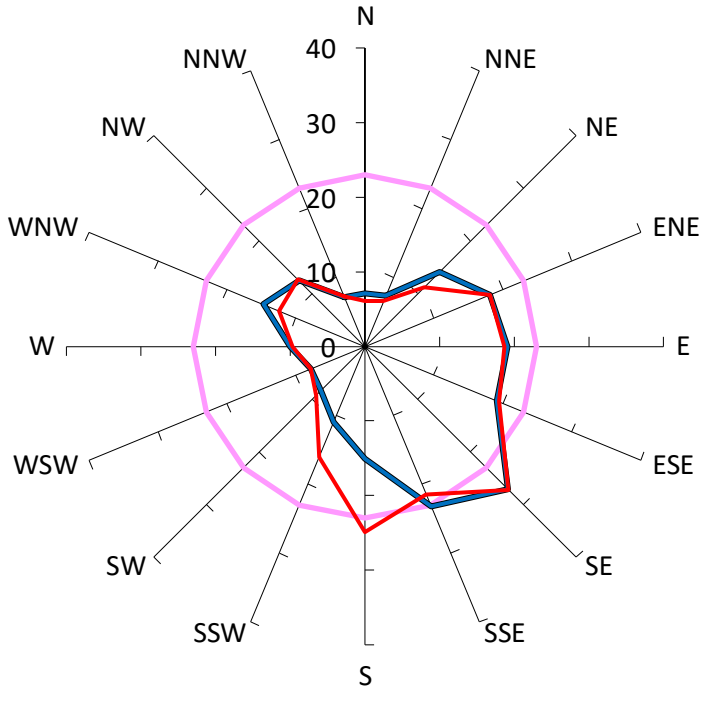
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	3%	23
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	2%	22

Results for Point 68

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

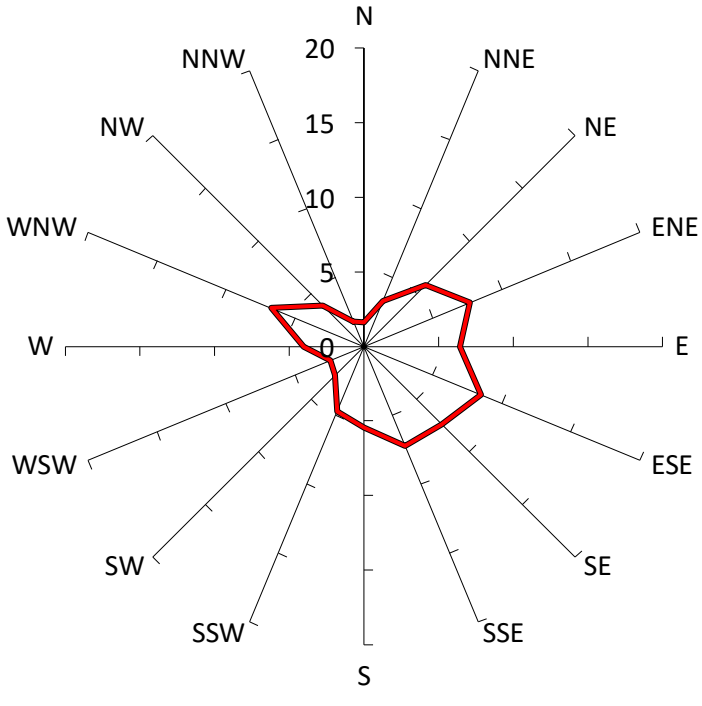


Safety Limit: 23m/s

Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 1 Case.	9%	27
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	9%	27

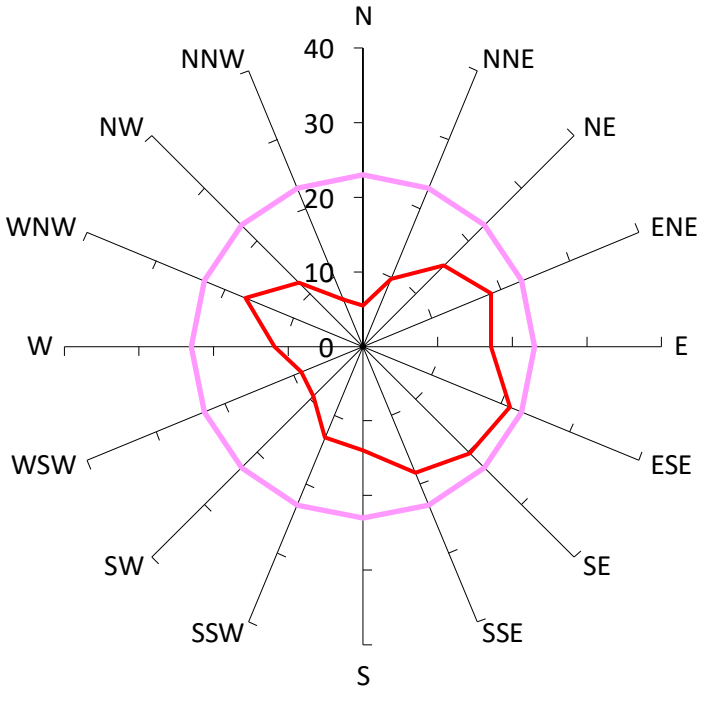
Results for Point 70

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

Maximum Gust (m/s)

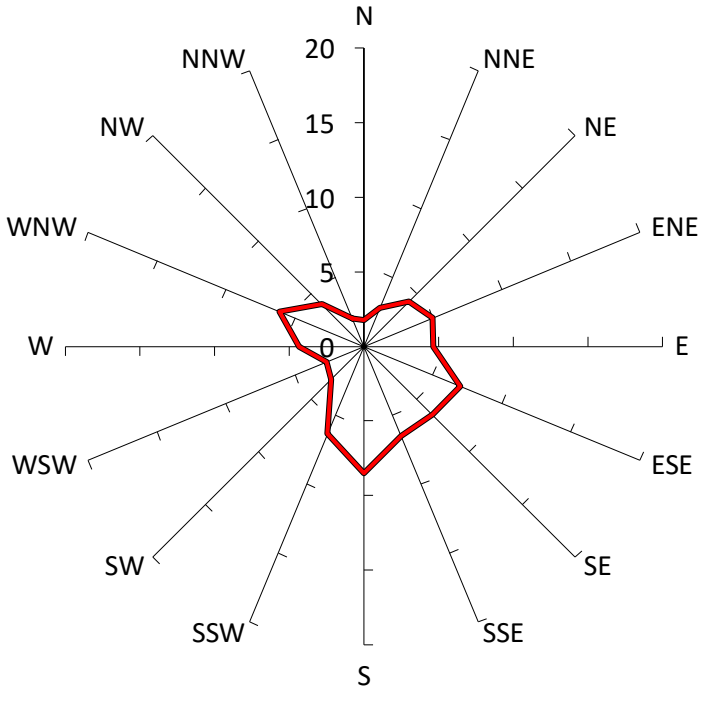


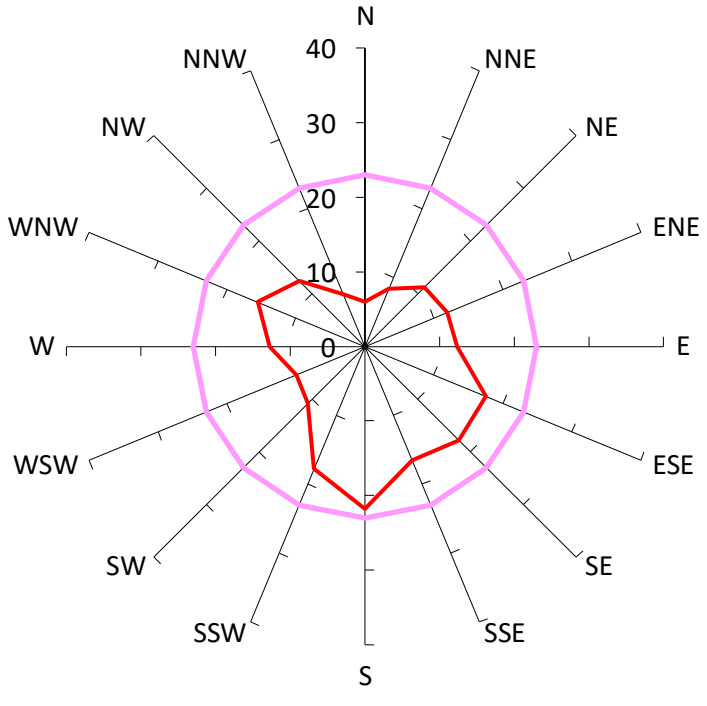
Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	4%	21

Results for Point 71

Gust Equivalent Mean (m/s)	Maximum Gust (m/s)





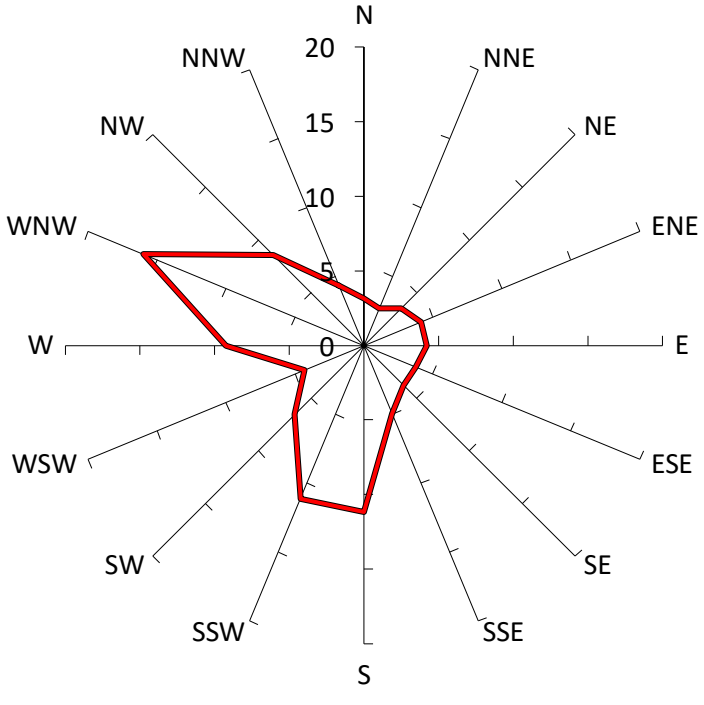
Comfort Criteria: 8m/s with 5% probability of exceedence

Safety Limit: 23m/s

	Description	GEM Prob of Exceed %	Peak Gust m/s
	Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
	With development "as proposed", no vegetation or other treatments. Stage 2 Case.	3%	22

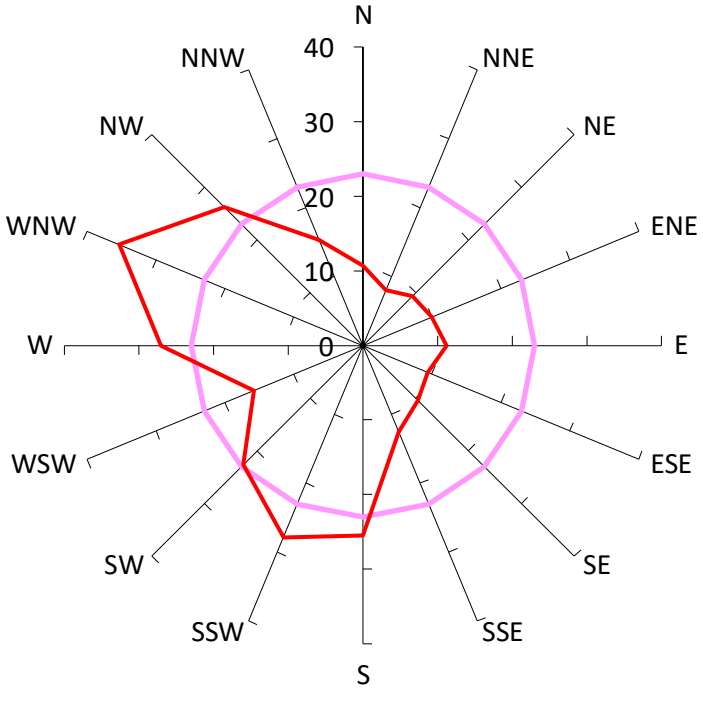
Results for Point 72

Gust Equivalent Mean (m/s)



Comfort Criteria: 8m/s with 5% probability of exceedence

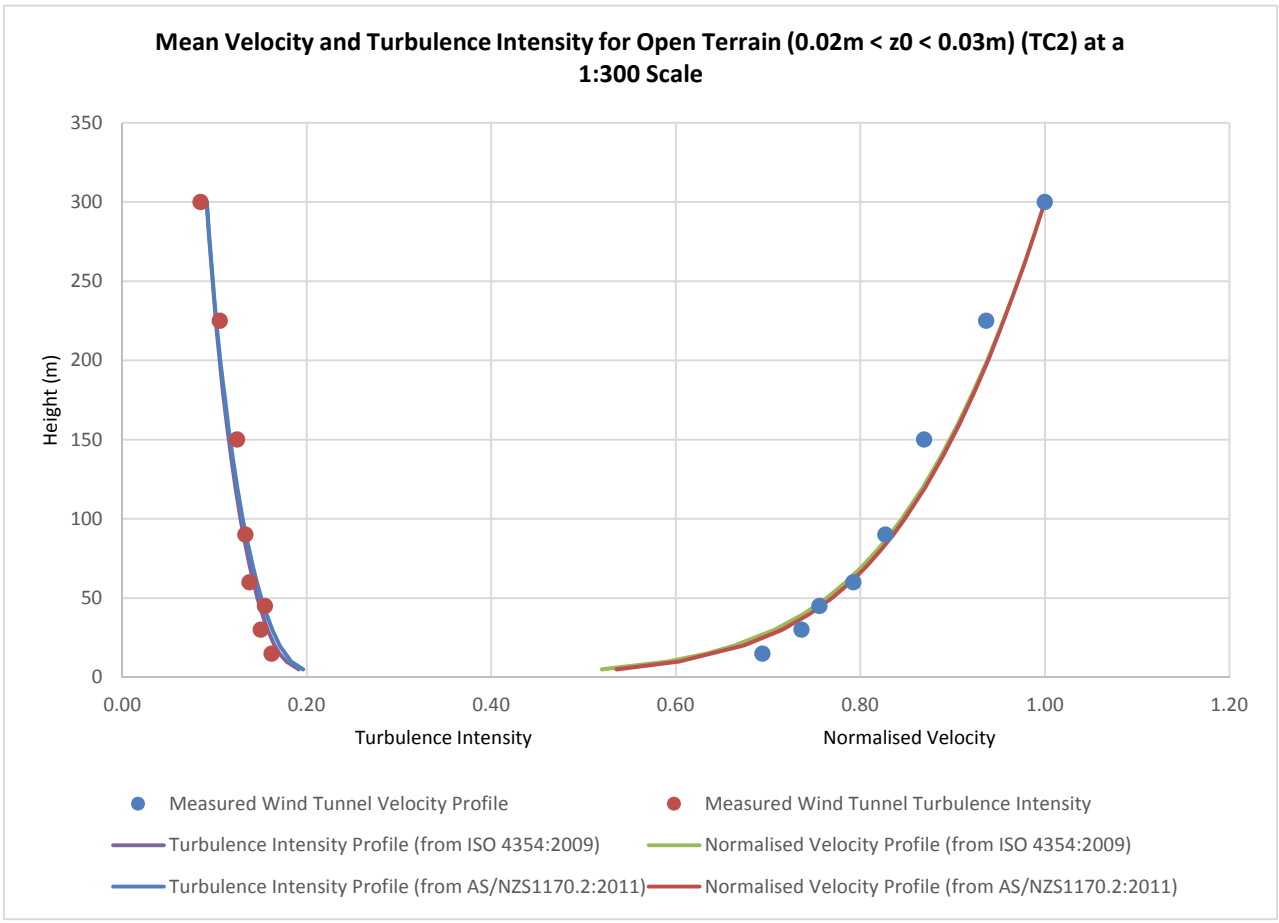
Maximum Gust (m/s)

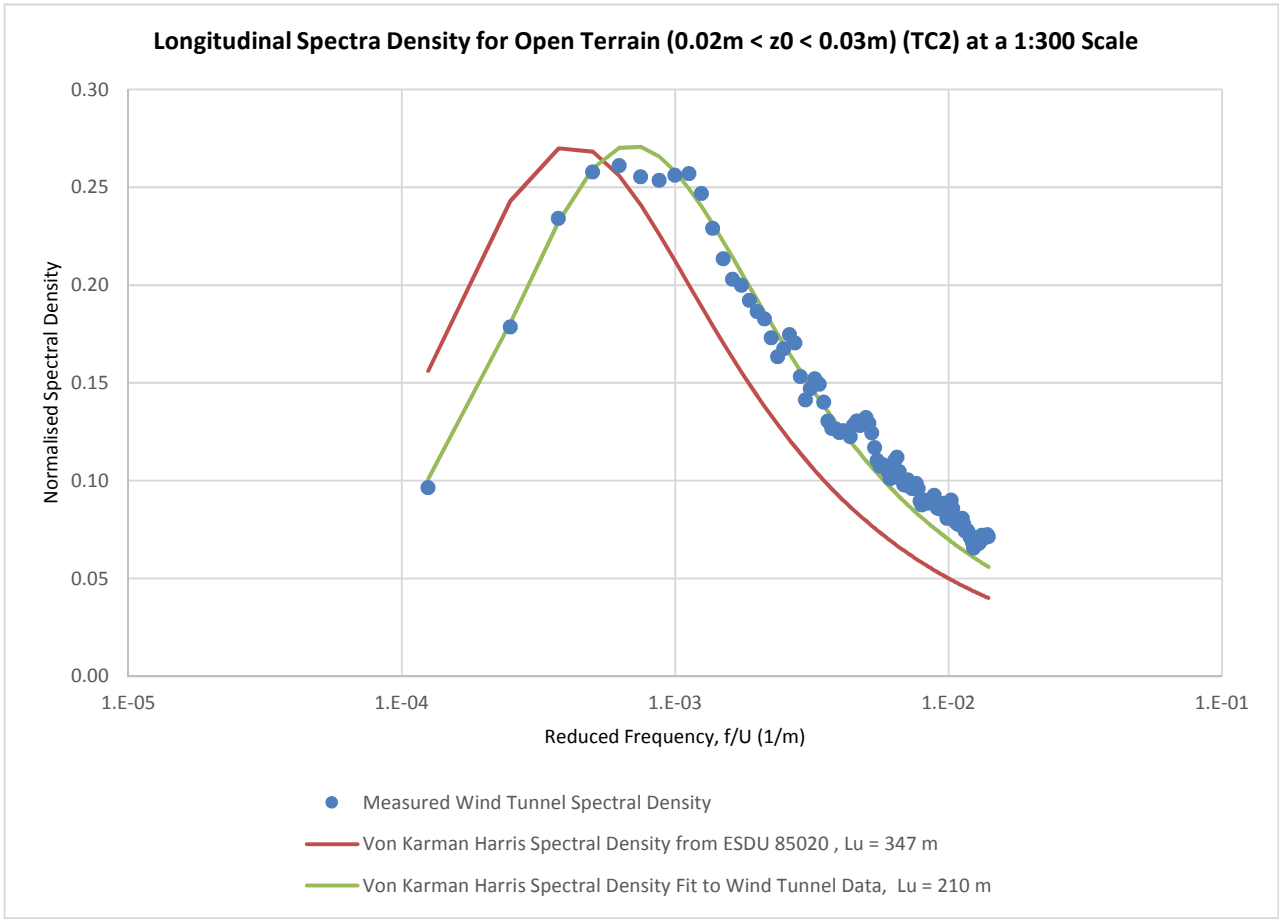


Safety Limit: 23m/s

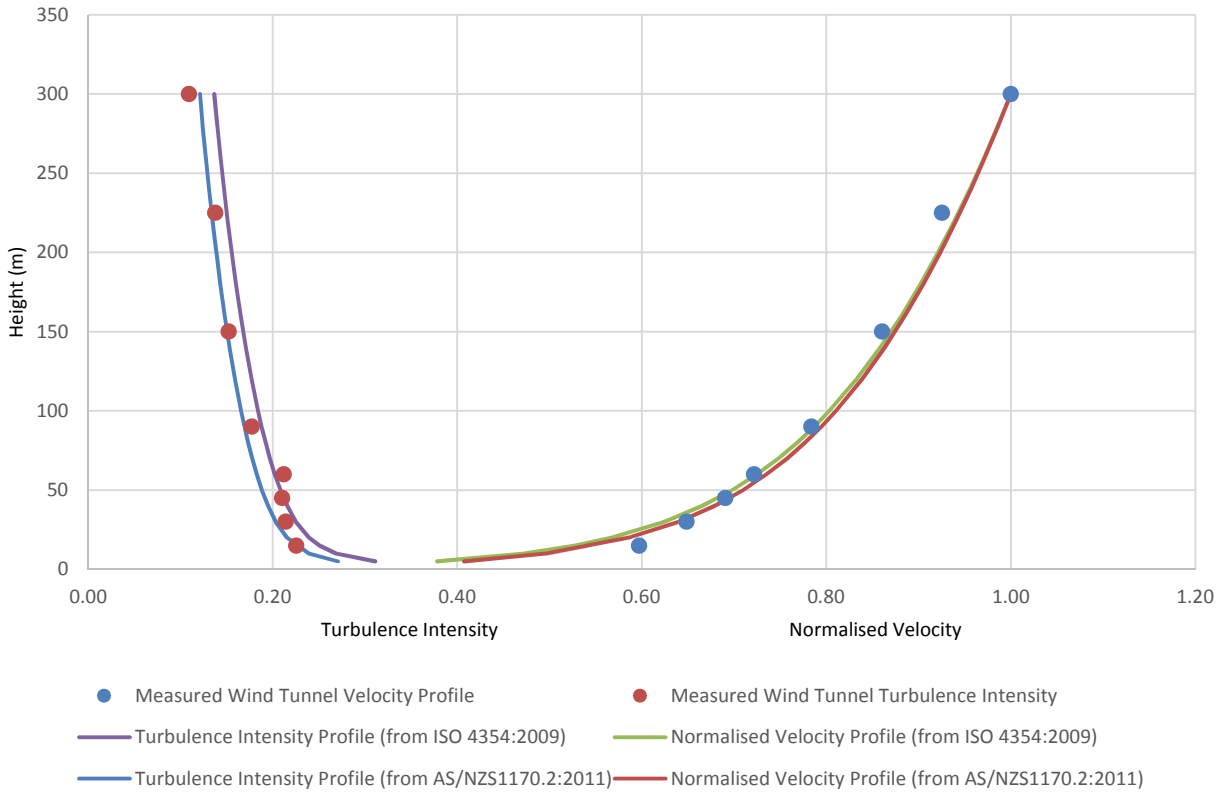
Description	GEM Prob of Exceed %	Peak Gust m/s
Criterion: Wind Comfort Standard for Walking Criterion (8m/s). Safety Limit (23m/s).	5%	23
With development "as proposed", no vegetation or other treatments. Stage 2 Case.	20%	35

APPENDIX D VELOCITY AND TURBULENCE INTENSITY PROFILES


Mean Velocity and Turbulence Intensity for Open Terrain (0.02m < z0 < 0.03m) (TC2) at a 1:300 Scale
Height (m)
350
300
250
200
150
100
50
0
0.00
0.20
0.40
0.60
0.80
1.00
1.20
Turbulence Intensity
Normalised Velocity
Measured Wind Tunnel Velocity Profile
Measured Wind Tunnel Turbulence Intensity
Turbulence Intensity Profile (from ISO 4354:2009)
Normalised Velocity Profile (from ISO 4354:2009)
Turbulence Intensity Profile (from AS/NZS1170.2:2011)
Normalised Velocity Profile (from AS/NZS1170.2:2011)


Longitudinal Spectra Density for Open Terrain (0.02m < z0 < 0.03m) (TC2) at a 1:300 Scale
Normalised Spectral Density
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
Reduced Frequency, f/U (1/m)
Measured Wind Tunnel Spectral Density
Von Karman Harris Spectral Density from ESDU 85020 , Lu = 347 m
Von Karman Harris Spectral Density Fit to Wind Tunnel Data, Lu = 210 m

Mean Velocity and Turbulence Intensity for Suburban/Forest Terrain (0.2m < z0 < 0.3m) (TC3) at a 1:300 Scale



Longitudinal Spectra Density for Suburban/Forest Terrain (0.2m < z0 < 0.3m) (TC3) at a 1:300 Scale